

PROJECT MANUAL

CMHA COBBLESTONE MANOR

**1050 LAMPLIGHTER DRIVE
GROVE CITY, OHIO 43222**

PREPARED FOR:



**COLUMBUS METROPOLITAN
HOUSING AUTHORITY**
COMMUNITY. COMMITMENT. COLLABORATION.

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COLUMBUS, OHIO

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JUNE 8, 2023**

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SECTION 21 05 17

SLEEVES AND SLEEVE SEALS FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.2 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 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems
 - 2. GPT
 - 3. Metraflex
 - 4. Pipeline Seal and Insulator.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

- 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.
- 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 Division 07.
- 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 Division 07.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls and Concrete Slab on Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 21 05 17

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SECTION 21 05 18
ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed or exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel 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 inside diameter closely fitting around outside diameter of piping and piping insulation and with outside diameter completely covering opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Uninsulated Piping: One-piece steel or split-plate steel.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter closely fitting around piping and piping insulation and with outside diameter completely covering opening.
 - 1. New Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 21 05 18

SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.
4. Pipe stands.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for fire protection piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment.

1.4 SUBMITTALS

A. Action Submittals:

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

2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Pipe stands.
 - B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.
 - C. Informational Submittals:
 1. Welding certificates.
 - D. Closeout Submittals:
 1. Operation and Maintenance Data
- 1.5 QUALITY ASSURANCE
- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
 - C. SMACNA.
 - D. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 1. B-line Systems, Inc; a division of Cooper Industries.
 2. Carpenter & Paterson, Inc.
 3. ERICO/Michigan Hanger Co.
 4. Globe Pipe Hanger Products, Inc.
 5. Grinnell Corp.
 6. Hilti North America.

7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.

B. Carbon-Steel Pipe Hangers and Supports:

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

C. Saddles

1. Material Galvanized Steel, 180-degree shape, each saddle marked with insulation O.D. Standard manufacturers gauge per insulated pipe size.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-

2.3 FASTENER SYSTEMS

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

2.4 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- J. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use padded hangers for piping that is subject to scratching.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

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

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

END OF SECTION 21 05 29

SECTION 21 05 53

IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Stencils.
4. Valve tags.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Samples: For color, letter style, and graphic representation required for each identification material and device.
3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
4. Valve numbering scheme.

B. Closeout Submittal:

1. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number where equipment is specified.

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

2.2 PIPE LABELS

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

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

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.4 VALVE TAGS

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

1. Tag Material: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain, or beaded chain, or S-hook.

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

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve or control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.

2. Fire Protection Piping:
 - a. Background: Red.
 - b. Letter Colors: White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape: 1-1/2 inches, round.
 2. Valve-Tag Colors: Natural.
 3. Letter Colors: Black.

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SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinklers.
 - 4. Alarm devices.
 - 5. Backflow Preventer.
 - 6. Pressure gages.

1.2 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.3 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Contractor to perform a flow test and utilize results of flow test for system design.
- C. Sprinkler system design shall be reviewed and approved by the design Fire Protection Engineer before being submitted for approval by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:

- a. Automobile Parking Areas: Ordinary Hazard, Group 1.
 - b. Building Service Areas: Ordinary Hazard, Group 1.
 - c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - d. Elevator Machine Rooms: Ordinary Hazard, Group 1.
 - e. General Storage Areas: Ordinary Hazard, Group 1.
 - f. Laundries: Ordinary Hazard, Group 1.
 - g. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - h. Office and Public Areas: Light Hazard.
3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft.
 4. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work. Also include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Domestic water piping.
 2. Compressed air piping.
 3. HVAC hydronic piping.
 4. Items penetrating finished ceiling include the following: Lighting fixtures, Air outlets and inlets.

- E. Qualification Data: For qualified Installer and NICET designer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, for approval by the design fire protection engineer before sending for approval by authorities having jurisdiction, including hydraulic calculations if applicable. Identify sprinkler heads by the same designations used in their agency approval documents.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems. Base calculations on results of fire-hydrant flow test. Design shall be signed by a NICET Level III or IV and for review by the design FPE.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
- D. Grooved Products: If grooved products are used, provide couplings, fittings, valves, and specialties from a single manufacturer.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify Architect and/or Owner no fewer than five days in advance of proposed interruption of sprinkler service.
 - 2. Do not proceed with interruption of sprinkler service without Architect's and/or Owner's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized, Steel Couplings: ASTM A 865, threaded.
- E. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175 psig minimum.
2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe. Short-pattern fittings with flow characteristics similar to standard fittings are acceptable.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber center-leg gasket with pipe stop, and ASTM A449 bolts and nuts.
 - a. Rigid Type: Housings cast with offsetting angle-pattern bolt pads for rigidity and support. Basis of Design: Victaulic 107N.
 - b. Flexible Type: Where vibration attenuation or stress relief are required. Basis of Design: Victaulic 77 or 177.

2.3 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F, with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
- B. CPVC Fittings: UL listed or FM approved, for 175-psig rated pressure at 150 deg F, socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
 1. NPS 3/4 to NPS 1-1/2: ASTM F 438 and UL 1821, Schedule 40, socket type.
 2. NPS 2 to NPS 3: ASTM F 439 and UL 1821, Schedule 80, socket type.
 3. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 4. Flanges: CPVC, one or two pieces.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.

1. Use solvent cement that has a VOC content of 490 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 650 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Coordinate submittal requirements of the VOC information with the LEED application requirements.
- D. Grooved-Joint Lubricants: Lubricant approved for the gasket elastomer and fluid media by the grooved-joint coupling manufacturer.
- E. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 COVER SYSTEM FOR SPRINKLER PIPING

- A. Description: System of support brackets and covers made to protect sprinkler piping.
- B. Brackets: Glass-reinforced nylon.
- C. Covers: Extruded PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.6 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
1. Valves shall be UL listed or FM approved.
 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
- B. Ball Valves:
1. Standard: UL 1091 except with ball instead of disc.
 2. Valves NPS 1-1/2 and Smaller: Bronze or brass body with threaded or grooved ends.
 3. Valves NPS 2: Bronze body with threaded ends or ductile-iron body with grooved ends.
- C. Check Valves:
1. Standard: UL 312.
 2. Pressure Rating: 250 psig minimum.
 3. Type: Spring-assisted swing check.
 4. Body Material: Ductile iron.
 5. End Connections: Flanged or grooved.
- D. Bronze OS&Y Gate Valves:
1. Standard: UL 262.
 2. Pressure Rating: 175 psig.

3. Body Material: Bronze.
4. End Connections: Threaded.

E. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

F. Indicating-Type Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball.
 - b. Body Material: Bronze or brass.
 - c. End Connections: Threaded or grooved.
4. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - d. Seat: Pressure-responsive elastomer.
 - e. Stem: Stainless steel, offset from the disc centerline to provide complete seating.
5. Valve Operation: Weatherproof actuator housing with integral electrical, 125-V ac, prewired, single-circuit, supervisory switch indicating device.

2.7 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: Standard-Pressure Piping Specialty Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation. Valve internal components replaceable without removing valve from piping.

3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection, Test, and Drain Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Bronze or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved ends.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Brass or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved ends.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid. Hose of type 304 stainless steel braid over flexible tube with threaded male fitting or coupling at one end and reducer and female threaded connection at other end. Union joints.
3. Pressure Rating: 175 psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.9 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Sprinklers shall be quick-response type heads. Sprinklers with "O" rings are prohibited.
4. Sprinklers shall have hexagonal wrench boss cast into body.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

1. Characteristics:

- a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.
- b. Nominal 17/32-inch Orifice: With Discharge Coefficient K between 7.4 and 8.2.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Escutcheons listed, furnished, and approved for use with sprinkler heads provided.

1. Ceiling Mounting: Plastic, white finish, one piece, flat.
2. Sidewall Mounting: Plastic, white finish, one piece, flat.

F. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.
3. Guards listed, furnished, and approved for use with sprinkler heads provided.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 8-inch minimum- diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for 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 if removed.
4. Type: Paddle operated.
5. Pressure Rating: .
6. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.11 BACKFLOW PREVENTERS

A. Double-Check, Detector-Assembly Backflow Preventers:

1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
2. Operation: Continuous-pressure applications.
3. Pressure Loss: maximum, through middle one-third of flow range.
4. Size: As required per contract documents.
5. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
6. End Connections: Flanged.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
 - a. Valves: UL 262 and FM Global's "Approval Guide" listing; 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. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.12 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

- C. Pressure Gage Range: 0 to 250 psig minimum. Provide pressure
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

2.13 FIRE-DEPARTMENT CONNECTION

- A. Yard-type:
 - 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. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Fire Protection Products, Inc.
 - d. GMR International Equipment Corporation.
 - e. Guardian Fire Equipment, Inc.
 - f. Potter Roemer.
 - g. Wilson & Cousins Inc.
 - 2. Standard: UL 405.
 - 3. Type: Exposed, freestanding.
 - 4. Pressure Rating: 175 psig minimum.
 - 5. Body Material: Corrosion-resistant metal.
 - 6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 - 7. Caps: Brass, lugged type, with gasket and chain.
 - 8. Escutcheon Plate: Round, brass, floor type.
 - 9. Outlet: Bottom, with pipe threads.
 - 10. Number of Inlets: Two.
 - 11. Sleeve: Brass.
 - 12. Sleeve Height: 18 inches.
 - 13. Escutcheon Plate Marking: Similar to "AUTO SPKR."
 - 14. Finish, Including Sleeve: Polished chrome plated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 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 spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.

3.4 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- M. Fill sprinkler system piping with water.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- O. Install sleeve seals for piping penetrations of exterior concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install yard-type fire-department connections in concrete slab support.
- B. Install automatic (ball-drip) drain valve at each check valve for fire-department connection

3.6 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer's published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Grooved-joint coupling manufacturer to provide factory-trained field representative for on-site training for contractor's personnel in proper grooved-joint item fabrication and installation procedures. Representative shall periodically visit job site to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer's published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Grooved-joint coupling manufacturer to provide factory-trained field representative for on-site training for contractor's personnel in proper grooved-joint item fabrication and installation procedures. Representative shall periodically visit job site to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- K. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- M. 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. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.7 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.8 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.9 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.
- D. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or have a cracked glass bulb.
- E. The sprinkler bulb protector shall be removable by hand without tools or devices that may damage the bulb.

3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.14 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. CPVC pipe; Schedule 40 or Schedule 80 CPVC fittings; and solvent-cemented joints may be used for light-hazard and residential occupancies.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.15 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 3. Wall Mounting: Sidewall sprinklers.
 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers and sidewall, dry sprinklers.
 5. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
 6. Special Applications: Extended-coverage and flow-control where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 4. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

SECTION 21 13 16

DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinklers.
 - 4. Alarm devices.
 - 5. Control panels.
 - 6. Pressure gages.

1.2 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.3 SYSTEM DESCRIPTIONS

- A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Contractor to perform a flow test and utilize results of flow test for system design.
- C. Sprinkler system design shall be reviewed and approved by the design Fire Protection Engineer before being submitted for approval by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Minimum Density for Automatic-Sprinkler Piping Design:

- a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft.
3. Maximum Protection Area per Sprinkler:
 - a. Attic Areas: 130 sq. ft.
 - b. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work. Also include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Domestic water piping.
 2. Compressed air piping.
 3. HVAC hydronic piping.
 4. Items penetrating finished ceiling include the following: Lighting fixtures, Air outlets and inlets.
- E. Qualification Data: For qualified Installer and NICET designer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, for approval by the design fire protection engineer before sending for approval by authorities having jurisdiction, including hydraulic calculations if applicable. Identify sprinkler heads by the same designations used in their agency approval documents.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems. Base calculations on results of fire-hydrant flow test. Design shall be signed by a NICET Level III or IV and for review by the design FPE.

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

C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

D. Grooved Products: If grooved products are used, provide couplings, fittings, valves, and specialties from a single manufacturer.

1.7 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized, Steel Couplings: ASTM A 865, threaded.
- D. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- I. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 175 psig minimum.
 - 2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe. Short-pattern fittings with flow characteristics similar to standard fittings are acceptable.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber center-leg gasket with pipe stop, and ASTM A449 bolts and nuts.
 - a. Rigid Type: Housings cast with offsetting angle-pattern bolt pads for rigidity and support. Basis of Design: Victaulic 107N.
 - b. Flexible Type: Where vibration attenuation or stress relief are required. Basis of Design: Victaulic 77 or 177.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Grooved-Joint Lubricants: Lubricant approved for the gasket elastomer and fluid media by the grooved-joint coupling manufacturer.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

B. Ball Valves:

1. Standard: UL 1091 except with ball instead of disc.
2. Valves NPS 1-1/2 and Smaller: Bronze or brass body with threaded or grooved ends.
3. Valves NPS 2: Bronze body with threaded ends or ductile-iron body with grooved ends.

C. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 250 psig minimum.
3. Type: Spring-assisted swing check.
4. Body Material: Ductile iron.
5. End Connections: Flanged or grooved.

D. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig.
3. Body Material: Bronze.
4. End Connections: Threaded.

E. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

F. Indicating-Type Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball.
 - b. Body Material: Bronze or brass.
 - c. End Connections: Threaded or grooved.
4. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.

- b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - d. Seat: Pressure-responsive elastomer.
 - e. Stem: Stainless steel, offset from the disc centerline to provide complete seating.
5. Valve Operation: Weatherproof actuator housing with integral electrical, 125-V ac, prewired, single-circuit, supervisory switch indicating device.

2.5 SPECIALTY VALVES

A. General Requirements:

B. 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.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

C. Dry-Pipe Valves:

1. Standard: UL 260
2. Design: Differential-pressure type.
3. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
4. Air-Pressure Maintenance Device:
 - a. Standard: UL 260.
 - b. Type: Automatic device to maintain minimum air pressure in piping.
 - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.
5. Air Compressor:
 - a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - b. Motor Horsepower: Fractional.
 - c. Power: 120-V ac, 60 Hz, single phase.

D. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection, Test, and Drain Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Bronze or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved ends.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Brass or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved ends.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.7 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Sprinklers shall be quick-response type heads. Sprinklers with "O" rings are prohibited.
4. Sprinklers shall have hexagonal wrench boss cast into body.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

1. Characteristics:

- a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.
- b. Nominal 17/32-inch Orifice: With Discharge Coefficient K between 7.4 and 8.2.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

E. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.
3. Guards listed, furnished, and approved for use with sprinkler heads provided.

2.8 ALARM DEVICES

- ### A. Alarm-device types shall match piping and equipment connections.

B. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

C. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

2.9 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FM Global approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.

2.10 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0 to 250 psig minimum. Provide pressure
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.
- K. Connect compressed-air supply to dry-pipe sprinkler piping.
- L. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire-alarm devices, including low-pressure alarm.
- M. Install alarm devices in piping systems.
- N. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
- O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and

valve. Install gages to permit removal and install where they will not be subject to freezing.

- P. Drain dry-pipe sprinkler piping.
- Q. Pressurize and check dry-pipe sprinkler system piping, air-pressure maintenance devices and air compressors.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer's published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Grooved-joint coupling manufacturer to provide factory-trained field representative for on-site training for contractor's personnel in proper grooved-joint item fabrication and installation procedures. Representative shall periodically visit job site to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer's published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Grooved-joint coupling manufacturer to provide factory-trained field representative for on-site training for contractor's personnel in proper grooved-joint item fabrication and installation procedures. Representative shall periodically visit job site to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- K. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Dry-Pipe and Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air supply piping.
 - b. Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer;

pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.

- c. Install compressed-air supply piping from building's compressed-air piping system.

3.5 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.6 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.8 CLEANING

- A. Clean dirt and debris from sprinklers.

- B. Remove and replace sprinklers with paint other than factory finish.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.10 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Standard-pressure, dry-pipe sprinkler system, NPS 4 and smaller, shall be the following:
 - 1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Spaces Subject to Freezing: Upright, dry pendent sprinklers.
 - 2. Special Applications: Extended-coverage and quick-response sprinklers where indicated.

END OF SECTION 21 13 16

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.2 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 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems
 - 2. GPT
 - 3. Metraflex
 - 4. Pipeline Seal and Insulator.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

- 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.
- 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 Division 07.
- 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 Division 07.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls and Concrete Slab on Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 22 05 17

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SECTION 22 05 18
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed or exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel 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 inside diameter closely fitting around outside diameter of piping and piping insulation and with outside diameter completely covering opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Uninsulated Piping: One-piece steel or split-plate steel.
 - c. Insulated Piping: One-piece stamped steel or split-plate stamped steel.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter closely fitting around piping and piping insulation and with outside diameter completely covering opening.
 - 1. New Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 22 05 18

SECTION 22 05 19

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Thermowells.
5. Dial-type pressure gauges.
6. Gauge attachments.
7. Test plugs.
8. Test-plug kits.
9. Sight flow indicators.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- ###### A. Product Certificates: For each type of meter and gauge, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- ###### A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- ###### 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. Ashcroft Inc.
2. Ernst Flow Industries.

3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Terice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.
- D. Dial: Non reflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle rigid, back and rigid, bottom, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1.5 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ashcroft Inc.
 - b. Marsh Bellofram.
 - c. Miljoco Corporation.
 - d. Palmer Wahl Instrumentation Group.
 - e. REOTEMP Instrument Corporation.
 - f. Terice, H. O. Co.

- g. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 5-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Glass or plastic
 - 9. Ring: Stainless steel
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

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

- 1. Manufacturers: Ashcroft, Terrice, Weiss
- 2. Standard: ASME B40.200.
- 3. Case: Cast aluminum; 6-inch nominal size.
- 4. Case Form: Straight unless otherwise indicated.
- 5. Tube: Glass with magnifying lens and blue or red organic liquid.
- 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C
- 7. Window: Glass or plastic.
- 8. Stem: Aluminum or brass and of length to suit installation.
- 9. Design for Thermowell Installation: Bare stem.
- 10. Connector: 3/4 inch, with ASME B1.1 screw threads.
- 11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 THERMOWELLS

A. Thermowells:

- 1. Standard: ASME B40.200.
- 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: Brass, type 304 stainless steel, or type 316 stainless steel.
4. Material for Use with Steel Piping: Type 304 stainless steel or type 316 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAUGES

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

1. Manufacturers: Ashcroft, Terrice, Weiss
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAUGE ATTACHMENTS

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

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

2.7 TEST PLUGS

A. Manufacturers: Terrice, Weiss, Watts

- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 SIGHT FLOW INDICATORS

- A. Manufacturers: Dwyer, OPW, Archon Industries
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 125 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

- G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- H. Install remote-mounted pressure gauges on panel.
- I. Install valve and snubber in piping for each pressure gauge for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
 - 4. Inlet and outlet of each remote domestic water chiller.
- L. Install pressure gauges in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Direct metal case, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
 - 4. Direct-mounted, light-activated type.
 - 5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Direct mounted, metal case, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
 - 4. Direct mounted, light-activated type.

5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

3.6 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges at discharge of each water service into building shall be one of the following:

1. Liquid-filled, direct mounted, metal case.
2. Sealed, direct mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each water pressure-reducing valve shall be the following:

1. Liquid-filled, direct mounted, metal case.
2. Sealed, direct mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each domestic water pump shall be the following:

1. Liquid-filled, direct mounted, metal case.
2. Sealed, direct mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi and 0 to 1100 kPa.

B. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

END OF SECTION 22 05 19

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SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Gate valves.
 - 5. Globe valves.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NPS: Nominal Pipe Size
- D. OS&Y: Outside screw and yoke.
- E. SWP: Steam working pressure.

1.3 SUBMITTALS

- A. Product Data: For each type of valve indicated, include: Body, seating and trim materials; valve design; pressure and temperature classifications; end connections, arrangements; dimensions and required clearances. Submit pressure drop curves for no-slam check valves. Include a list indicating valve type and its piping system application. Include rated capacities; shipping and operating weights and furnished specialties and accessories.
- B. Contract Closeout Information:
 - 1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
 - 2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
 - 1. Grooved end valves shall be of the same manufacturer as adjoining couplings.
- B. UL Compliance:
 - 1. NSF-61 for valves in potable water systems.
 - 2. NSF-372 for low-lead requirements.
- C. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
 - 4. ASME Boiler Code Specifications for Boiler Room valves.
- D. ASTM Compliance:
 - 1. ASTM B62 for 125 psi and 150 psi saturated steam rated valve pressure containing parts.
 - 2. ASTM B61 for 200 psi and 300 psi valves with metallic seats.
- E. Factory test all valve bodies, shells and seats per MSS requirements at a minimum.
- F. Iron Body Valves
 - 1. Pressure-Containing Parts: ASTM A126, Grade B or ASTM A536, Grade 65-45-12.
 - 2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
 - 3. Design, Workmanship, Materials, Testing: MSS SP-70, 71, 85.
- G. Butterfly Valves
 - 1. Face-to-Face and End-to-End Dimensions: MSS SP-67.
- H. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Pressure casting shall be free of impregnating materials, no welding of iron allowed.
- K. Manufacturer's name or trademark and working pressure stamped or cast into body.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooved ends, and weld ends.
 3. Set gate and globe valves closed to prevent rattling.
 4. Set ball valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
- B. Ball, Butterfly, Check, and Globe Valves:
1. Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Mueller or Victaulic.
- C. Gate, Check, and Globe Valves:
1. Milwaukee, Hammond, Crane or Flowserve.

2.2 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valves shall be rated for pressures and temperatures no less than 20% over that of the piping system in which they are installed. Account for piping system pressure tests when selecting component ratings.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 2. Handwheel: For valves other than quarter-turn types.
 3. Hand lever: For quarter-turn valves NPS 6 and smaller.
- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Threaded: With threads according to ASME B1.20.1.

2.3 BALL VALVES

A. Bronze Ball Valves:

1. Description:
 - a. Standard: MSS SP-110.
 - b. ANSI Class: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded or Soldered for copper piping.
 - g. Seats: Reinforced PTFE.
 - h. Stem: Stainless steel.
 - i. Ball: Chrome plate ball, vented.
 - j. Port: Full.
 - k. Operator: Hand Lever.

2.4 BUTTERFLY VALVES

A. Single-Flange, Butterfly Valves:

1. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - h. Operator: 10 Position Hand Lever for less than 6", Gear Actuator for 6" and larger.
 - i. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.

2.5 CHECK VALVES

A. Bronze Swing Check Valves:

1. Description:

- a. Standard: MSS SP-80, Type 3.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Design: Horizontal flow.
- e. Body Material: ASTM B 62, bronze.
- f. Ends: Threaded or Soldered for copper piping.
- g. Disc: Reinforced PTFE.
- h. Cap: Threaded.

2.6 GATE VALVES

A. Bronze Gate Valves:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. ANSI Class: 150
- c. CWP Rating: 300 psig.
- d. Body Material: ASTM B 62, cast bronze.
- e. Ends: Threaded.
- f. Stem: Non-Rising.
- g. Disc: Solid wedge; bronze.
- h. Packing: Asbestos free.
- i. Bonnet: Union
- j. Operator: Hand Wheel-Malleable iron.

B. Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Material: ASTM A 126, cast iron.
- e. Ends: Flanged.
- f. Wedge and Seat Rings Material: Cast bronze.
- g. Disc: Solid Wedge-Cast iron.
- h. Packing and Gasket: Asbestos free.
- i. Bonnet: Bolted
- j. Stem: O.S. & Y.
- k. Operator: Hand Wheel-Cast iron.

C. Forged Carbon Steel Gate Valves:

1. Description:
 - a. ANSI Class: 300 or 600
 - b. Body Material: ASTM A 105, forged carbon steel.
 - c. Ends: Flanged or weld.
 - d. Seat Ring Material: Hard faced stainless steel (Type 410).
 - e. Disc: Solid Wedge-Stainless steel (Type 410).
 - f. Bonnet: Bolted
 - g. Packing and Gasket: Asbestos free.
 - h. Stem: O.S. & Y.
 - i. Operator: Hand Wheel-Malleable iron.

D. Cast Steel Gate Valves:

1. Description:
 - a. ANSI Class: 300
 - b. Body Material: ASTM A 216, cast steel.
 - c. Ends: Flanged.
 - d. Seat Ring Material: Stellite hard facing over plain carbon steel.
 - e. Disc: Stainless steel (ASTM A 217).
 - f. Bonnet: Bolted.
 - g. Stem: O.S. & Y.
 - h. Operator: Hand Wheel-Malleable iron.

2.7 GLOBE VALVES

A. Bronze Globe Valves:

1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. ANSI Class: 150
 - c. Body Material: ASTM B 62, bronze.
 - d. Ends: Threaded or Flanged.
 - e. Stem: Rising.
 - f. Disc: 420 Stainless Steel.
 - g. Seat Ring Material: 420 Stainless Steel.
 - h. Bonnet: Union.
 - i. Operator: Hand Wheel-Malleable iron.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Examine grooved ends for form and cleanliness. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.

3.2 VALVE INSTALLATION

- A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings (the couplings shall serve as disconnect points if required).
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with handwheel and stem at or above center of pipe.
- F. Install valves in position to allow full stem movement.
- G. Install check valves for proper direction of flow and as follows: Swing Check Valves: In horizontal position with hinge pin level
- H. Install Start/Stop flow valve for isolation at each branch connection to supply main.
- I. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- J. All check valves should be installed in a location that has smooth and laminar flow conditions.
- K. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.
- L. Valves installed in copper lines shall be provided with screwed or flanged adapters with a union installed downstream and within 12" of the valve.

- M. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on the Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

3.5 PLUMBING SYSTEMS

- A. Pipe NPS 2 and Smaller:

1. Shutoff: Ball Valves.
2. Prevent Backflow: Lift Check Valves or Bronze Swing Check Valves.

- B. Pipe NPS 2-1/2 and Larger:

1. Shutoff: Butterfly Valves.
2. Prevent Backflow: Iron Swing Check Valves or Globe Body Silent Check Valves.

END OF SECTION 22 05 23

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe stands.
 - 6. Equipment supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment.

1.4 SUBMITTALS

- A. Action Submittals:

1. Product Data: For each type of product indicated.
 2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following: include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Pipe stands.
 - c. Equipment supports.
 3. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - a. Detail fabrication and assembly of trapeze hangers.
 - b. Design Calculations: Calculate requirements for designing trapeze hangers.
- B. Informational Submittals:
1. Welding certificates.
- C. Closeout Submittals:
1. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. SMACNA.
- D. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. B-line Systems, Inc; a division of Cooper Industries.
 2. Carpenter & Paterson, Inc.
 3. ERICO/Michigan Hanger Co.

4. Globe Pipe Hanger Products, Inc.
5. Grinnell Corp.
6. Hilti North America.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.

B. Carbon-Steel Pipe Hangers and Supports:

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

C. Saddles

1. Material Galvanized Steel, 180-degree shape, each saddle marked with insulation O.D. Standard manufacturers gauge per insulated pipe size.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Carpenter & Paterson, Inc.
 2. ERICO International Corporation.
 3. National Pipe Hanger Corporation.
 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig, or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

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

2.5 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

2.6 EQUIPMENT SUPPORTS

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

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts

before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

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

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

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

- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 22 05 29

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Samples: For color, letter style, and graphic representation required for each identification material and device.
3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
4. Valve numbering scheme.

B. Closeout Submittal:

1. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger

lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number where equipment is specified.

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

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

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

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger

lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

- A. Stencils for Piping:
 - 1. Lettering Size: Size letters according to ASME A13.1 for piping.
 - 2. Stencil Material: Fiberboard or metal.
 - 3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 4. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
- B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:
 - 1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 - 2. Stencil Material: Fiberboard or metal.
 - 3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.

4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain, or beaded chain, or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve or control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both side of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 25 feet along each run.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 3. Fuel Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape: 1-1/2 inches, round.
 - 2. Valve-Tag Colors: Natural.
 - 3. Letter Colors: Black.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 22 05 53

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating plumbing piping systems.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. 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.

1.4 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.
- B. Protection: Do not permit mineral fiber or calcium silicate insulation to get wet. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with piping Installer for piping insulation application.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. 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.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Non-flexible Fiberglass
 - 1. O-C fiberglass ASJ/SSL-II pipe insulation with all service jacket (ASJ).
 - 2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
 - 3. 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. Manville
 - b. Owens Corning Insulating Systems, LLC.
 - c. Manson
 - d. Knauf.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 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. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

2. Properties:

- a. Maximum Operating Temperature: 180 deg F.
- b. Minimum Operating Temperature: -70 deg F.
- c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
- d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
- e. Maximum Water Absorption by Volume: 0.2%.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 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 F.
 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.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.5 SEALANTS

- A. 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.
- B. 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.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. All-Service Jacket (ASJ): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
 - 2. All-Service Jacket – Self-Sealing Lap (ASJ-SSL): ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.

3. Foil-Scrim Kraft (FSK) Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Maximum water vapor permeance 0.02 perms.

2.7 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.

2.8 FIELD-APPLIED CLOTHS

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

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Adhesive as recommended by jacket material manufacturer.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Johns Manville; Ceel-Co or Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Color: White unless indicated otherwise.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
- D. Metal Jacket:
 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.

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.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- 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. 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 in accordance with manufacturers' instructions.
- B. 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.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system.
- D. 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.

- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the job site.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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 on center.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
 - 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.

- N. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- O. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 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 firestopping section.
- 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 firestopping section.

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 more. 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 more. 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 more.
 - 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, 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as 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 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 preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF NON-FLEXIBLE PIPE INSULATION

- A. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation. Do not staple cold piping. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.
- B. Installation of Insulation of Fittings
 1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
 2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
 3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
 4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
 5. Install in accordance with manufacturer's recommendations

3.8 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; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

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 on center and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped along length of roll with 2-inch-overlap seal. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as indicated. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 2 or Smaller: Insulation shall be one of the following:
 - a. Fiberglass: 1/2 inches thick
 - b. Flexible Elastomeric: 1/2 inch thick.
2. NPS 2-1/2 or Larger: Insulation shall be one of the following:
 - a. Fiberglass: 1 inches thick

B. Domestic Hot Water:

1. NPS 1-1/2 or Smaller: Insulation shall be one of the following:
 - a. Fiberglass: 1 inches thick
2. NPS 2 and Larger: Insulation shall be one of the following:
 - a. Fiberglass: 1-1/2 inches thick

C. Storm Water, Roof Drain, and Overflow Roof Drain (Including Drain Bodies):

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Fiberglass: 1 inches thick
 - b. Flexible Elastomeric: 1 inch thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be as described in Protective Shielding Guards article above.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed: None.
- D. Piping, Exposed:
 - 1. PVC, Color-Coded by System: 20 mils thick.
 - 2. Aluminum, Smooth: 0.020 inch thick.
 - 3. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.016 inch thick.

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SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- B. Product Data: For grooved-joint couplings and fittings.

1.3 INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. NSF Compliance:
 1. NSF-61 for components in potable water systems.
 2. NSF-372 for low-lead requirements.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint 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. Elkhart Products Corporation.
 - b. NIBCO Inc.
 - c. Viega.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

2.4 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.5 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.6 PEX-AL-PEX TUBE AND FITTINGS

A. PEX-AL-PEX Distribution System: ASTM F 1281 tubing.

- B. Fittings for PEX-AL-PEX Tube: ASTM F 1281, metal-insert type with copper or stainless-steel crimp rings and matching PEX-AL-PEX tube dimensions.

2.7 PEX-AL-HDPE TUBE AND FITTINGS

- A. PEX-AL-HPDE Distribution System: ASTM F 1986 tubing.
- B. Fittings for PEX-AL-HDPE Tube: ASTM F 1986, metal-insert type with copper or stainless-steel crimp ring and matching PEX-AL-HDPE tube dimensions

2.8 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
 - 1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.9 TRANSITION FITTINGS

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

- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Piping Specialties Products.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc.; a Sensus company.
 - g. Viking Johnson.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 - 2. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Colonial Engineering, Inc.
 - b. NIBCO Inc.
 - c. Spears Manufacturing Company.
 - 2. Description:
 - a. CPVC four-part union.
 - b. Brass or stainless-steel threaded end.
 - c. Solvent-cement-joint or threaded plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

2.10 DIELECTRIC FITTINGS

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

- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.

- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
 - 2. Standard: ASSE 1079.
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 125 psig minimum at 180 deg F.
 - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

- D. Dielectric-Flange Insulating 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. Advance Products & Systems, Inc.
 - b. Calpico, Inc.

- c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Nonconducting materials for field assembly of companion flanges.
 - 3. Pressure Rating: 150 psig.
 - 4. Gasket: Neoprene or phenolic.
 - 5. Bolt Sleeves: Phenolic or polyethylene.
 - 6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
 - f. .
 - 2. Standard: IAPMO PS 66.
 - 3. Electroplated steel nipple complying with ASTM F 1545.
 - 4. Pressure Rating and Temperature: 300 psig at 225 deg F.
 - 5. End Connections: Male threaded or grooved.
 - 6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

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

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with

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

- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level without pitch and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install PEX piping with loop at each change of direction of more than 90 degrees.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joint Construction for Solvent-Cemented Plastic Piping: 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. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- I. Joints for PEX Piping: Join according to ASTM F 1807.

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

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

- H. Install supports for vertical steel piping every 15 feet.
- I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
- J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- K. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
- L. Install hangers for vertical PEX piping every 48 inches.
- M. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
- N. Install supports for vertical PP piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- O. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:

- 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 2. PP, SDR 11 socket fittings; and fusion-welded joints.
- D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

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

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. CPVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
3. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. PEX tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.
5. PEX-AL-PEX tube, NPS 1 and smaller; fittings for PEX-AL-PEX tube; and crimped joints.

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

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

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Drain Duty: Hose-end drain valves.

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

END OF SECTION 22 11 16

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SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Strainers.
5. Outlet boxes.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.
9. Water-hammer arresters.
10. Air vents.
11. Specialty valves.
12. Flexible connectors.
13. Water meters.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; a division of Watts Water Technologies, Inc.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Arrowhead Brass Products.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.

- g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1011.
 3. Body: Bronze, nonremovable, with manual drain.
 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 5. Finish: Chrome or nickel plated

C. Pressure Vacuum Breakers

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Toro Company (The); Irrigation Div.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: See Drawings Design Flow Rate: See Drawings
6. Selected Unit Flow Range Limits: See Drawings
7. Pressure Loss at Design Flow Rate: See Drawings
8. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8 or NPS 1/2 or NPS 3/4 or NPS 1.

5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Size: See Drawings
6. Design Flow Rate: See Drawings
7. Selected Unit Flow Range Limits: See Drawings
8. Body: Bronze for NPS 2 and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
10. Configuration: Designed for horizontal, straight-throughflow.
11. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
2. Standard: ASSE 1052.

3. Operation: Up to 10-foot head of water back pressure.
4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least 3-gpm flow.

C. 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.
 - b. FEBCO; a division of Watts Water Technologies, Inc.
 - c. Flomatic Corporation.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. Honeywell International Inc.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering 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. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. Honeywell International Inc.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. Powers; a division of Watts Water Technologies, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Drain: Pipe plug.

2.8 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

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. Acorn Engineering Company.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. IPS Corporation.
 - d. LSP Products Group, Inc.
 - e. Oatey.
 - f. Plastic Oddities.
 - g. Symmons Industries, Inc.

- h. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - j. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - 2. Mounting: Recessed.
 - 3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
 - 4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
- B. Icemaker Outlet Boxes:
- 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. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Oatey.
 - e. Plastic Oddities.
 - 2. Mounting: Recessed.
 - 3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.

2.9 HOSE BIBBS

- A. Hose Bibbs:
- 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. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products.
 - e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - f. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products
 - 2. Standard: ASME A112.18.1 for sediment faucets.
 - 3. Include operating key with each operating-key hose bibb.

2.10 WALL HYDRANTS

- A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
2. Operating Keys(s): Two with each wall hydrant.

2.11 DRAIN VALVES

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

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products, Inc.

- e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Metal bellows.
 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 220523 "General-Duty Valves for Plumbing Piping."

B. CPVC Union Ball 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 Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. Georg Fischer LLC; GF Piping Systems.
 - e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
 - f. IPEX.
 - g. NIBCO Inc.
 - h. Spears Manufacturing Company.
 - i. Thermoplastic Valves Inc.
2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating and Temperature: 125 psig.
 - c. Body Material: CPVC.
 - d. Body Design: Union type.
 - e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
 - f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket, threaded or flanged.
 - g. Ball: CPVC; full port.
 - h. Seals: PTFE or EPDM-rubber O-rings.
 - i. Handle: Tee shaped.

C. CPVC Non-Union Ball 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 Valve, Inc.
- b. Asahi/America.
- c. KBI Company.
- d. Legend Valve.
- e. NIBCO Inc.
- f. Spears Manufacturing Company.
- g. Thermoplastic Valves Inc.

2. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating and Temperature: 125 psig.
- c. Body Material: CPVC.
- d. Body Design: Non-union type.
- e. End Connections: Socket or threaded.
- f. Ball: CPVC; full or reduced port.
- g. Seals: PTFE or EPDM-rubber O-rings.
- h. Handle: Tee shaped.

2.14 FLEXIBLE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.Universal Metal Hose; a Hyspan company.

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

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.15 WATER METERS

A. Displacement-Type Water Meters:

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. AALIAN; a Venture Measurement product line.ABB.Badger Meter, Inc.
 - b. Carlon Meter.
 - c. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - d. Schlumberger Limited; Water Services.
 - e. Sensus.
2. Description:
- a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. End Connections: Threaded.
- B. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
- C. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- D. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- E. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with

requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

- F. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Outlet boxes.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.3 FIELD QUALITY CONTROL

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

3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 24

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Pressure regulators.
 - 6. Dielectric fittings.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.

5. Service meters. Indicate pressure ratings and capacities. Include meter bars and supports.
 6. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot.
 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
 2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

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

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig or 100 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.

- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 - 6. Mechanical Couplings:
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steel bolts, washers, and nuts.
 - d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
 - 1. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 2. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.

3. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
4. Striker Plates: Steel, designed to protect tubing from penetrations.
5. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
6. Operating-Pressure Rating: 5 psig.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated, and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated, and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. PE body with molded-in, stainless-steel support ring.
 - b. Buna-nitrile seals.
 - c. Acetal collets.
 - d. Electro-zinc-plated steel stiffener.
6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Fiber-reinforced plastic body.

- b. PE body tube.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Stainless-steel bolts, nuts, and washers.
7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
- a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steel bolts, washers, and nuts.
 - d. Factory-installed anode for steel-body couplings installed underground.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. 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.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig .
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inchesto NPS 2 shall have initials "WOG" permanently marked on valve body.

- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft
 - b. Conbraco
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

- E. Bronze Plug Valves: MSS SP-78.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lee Brass
 - b. McDonald
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Plug: Bronze.
 - 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Operator: Square head or lug type with tamperproof feature where indicated.
 - 6. Pressure Class: 125 psig.
 - 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

- F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. McDonald

- b. Mueller
 - c. Xomox
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Homestead
 - b. McDonald
 - c. Mueller
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. PE Ball Valves: Comply with ASME B16.40.
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. Kerotest
 - b. Lyall
 - c. Perfection
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 5. Seats and Seals: Nitrile.
 6. Ends: Plain or fusible to match piping.
 7. CWP Rating: 80 psig.
 8. Operating Temperature: Minus 20 to plus 140 deg F.
 9. Operator: Nut or flat head for key operation.
 10. Include plastic valve extension.

11. Include tamperproof locking feature for valves where indicated on Drawings.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

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 Meter
 - b. Fisher
 - c. Invensys
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

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 Meter
 - b. Fisher
 - c. Invensys
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 10 psig .

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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. Eaton
 - b. Harper
 - c. Maxitrol
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 5 psig.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Watts
 - b. McDonald
 - c. Wilkins
 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Watts
 - b. McDonald
 - c. Wilkins
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pipeline Seal and Insulator
 - b. Calpico
 - c. Advanced Products & Systems
2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

b. Do not install natural-gas piping in solid walls or partitions.

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

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

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

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

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

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

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

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 VALVE INSTALLATION

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

B. Install underground valves with valve boxes.

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

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. 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.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 20548 "Vibration and Seismic Controls for Plumbing."
- B. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel gloss.
 - d. Color: Gray.
 - C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex gloss.
 - d. Color: Gray.
 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd gloss.
 - d. Color: Gray.
 - D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.
- 3.11 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
 - B. Tests and Inspections:
 1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
 - C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.12 OUTDOOR PIPING SCHEDULE
- A. Underground natural-gas piping shall be the following:
 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.

END OF SECTION 22 11 24

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

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

- A. Pipe and Fittings: ASTM A 74, Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Ideal Tridon
 - g. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of

Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 EARTH MOVING

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

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. 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.

- L. Lay buried building 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.
 - M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
 - N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
 - O. Install aboveground PVC piping according to ASTM D 2665.
 - P. Install underground PVC piping according to ASTM D 2321.
 - Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
 - S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
 - T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- 3.3 JOINT CONSTRUCTION
- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. 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.
- D. Plastic, Nonpressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.

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

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

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and 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.

3.5 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

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

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

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

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

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

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 and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders 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. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.9 PIPING SCHEDULE

- A. Aboveground, soil, waste and vent piping NPS 4 and smaller shall be one of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- B. Underground, soil, waste, and vent piping NPS 4 and smaller shall be one of the following:
 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Underground, soil and waste piping NPS 5 and larger shall be one of the following:
 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.

END OF SECTION 22 13 16

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Air-admittance valves.
 - 4. Roof flashing assemblies.
 - 5. Through-penetration firestop assemblies.
 - 6. Flashing materials.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - 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) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Drainage Products.
 - 6) Zurn Plumbing Products Group.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
- B. Metal Floor Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts:

- 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) Josam Company.
- 2) Oatey.
- 3) Sioux Chief Manufacturing Co., Inc.
- 4) Smith, Jay R. Mfg. Co.
- 5) Tyler Pipe.
- 6) Watts Drainage Products.
- 7) Zurn Plumbing Products Group.

2. Standard: ASME A112.36.2M.

C. Cast-Iron Wall Cleanouts:

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

- a. Josam Company; Josam Div.
- b. MIFAB, Inc.
- c. Smith, Jay R. Mfg. Co.
- d. Tyler Pipe; Wade Div.
- e. Watts Drainage Products.
- f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.

4. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

5. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Plastic Floor Cleanouts:

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

- a. Canplas LLC.
- b. IPS Corporation.
- c. NDS Inc.
- d. Plastic Oddities.
- e. Sioux Chief Manufacturing Company, Inc.

2. Body: PVC.

3. Closure Plug: PVC.

4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products.
 - h. Zurn Plumbing Products Group.
2. Standard: ASME A112.6.3.

B. Plastic Floor Drains:

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. Canplas LLC.
 - b. IPS Corporation.
 - c. Josam Company; Josam Div.
 - d. Oatey.
 - e. Plastic Oddities; a division of Diverse Corporate Technologies.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASME A112.6.3.

2.3 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ayrlett, LLC.
 - b. Durgo, Inc.
 - c. Oatey.
 - d. ProSet Systems Inc.
 - e. RectorSeal.
 - f. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.

5. Size: Same as connected fixture or branch vent piping.

B. Wall Box:

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. Durgo, Inc.
 - b. Oatey.
 - c. RectorSeal.
 - d. Studor, Inc.
2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
2. Description: Manufactured assembly of flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

D. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

E. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.

2.7 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

- 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. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install fixture air-admittance valves on fixture drain piping.
 - F. Install air-admittance-valve wall boxes recessed in wall.
 - G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
 - H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
 - I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
 - J. Assemble open drain fittings and install with top of hub 2 inches above floor.
 - K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
 - L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
 - M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
 - N. Install wood-blocking reinforcement for wall-mounting-type specialties.
 - O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 1. Copper Sheets: Solder joints of copper sheets.
- B. 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.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 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 22 13 19

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SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 50 psig.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

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

- A. Pipe and Fittings: ASTM A 74, Extra Heavy classes.
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Husky
 - b. Fernco
 - c. MIFAB
 - d. Mission
 - e. Tyler
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stops.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.
- B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12 threaded.
- C. Steel-Pipe Pressure Fittings:
 - 1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.5 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 EARTH MOVING

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

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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 from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for 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.
- K. 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.
- L. 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 NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 1 downward in direction of flow.
- M. 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."
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Install force mains at elevations indicated.
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

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

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- 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-piping coupling joints.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads 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.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- J. Install supports for vertical PVC piping every 48 inches.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
- D. Connect force-main piping to the following:
 - 1. Sump Pumps: To sump pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

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 until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. 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.

3.9 PIPING SCHEDULE

- A. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- B. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
 2. Galvanized-steel pipe, drainage fittings, and threaded joints.

- C. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Extra Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

- D. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
 - 1. Extra Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

- E. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be the following:
 - 1. Galvanized-steel pipe, pressure fittings, and threaded joints.

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SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof drains.
 - 2. Cleanouts.
 - 3. Through-penetration firestop assemblies.
 - 4. Flashing materials.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

- A. Cast-Iron, General-Purpose Roof Drains, Downspout Nozzles, Promenade Roof Drains:
 - 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. Josam
 - b. MIFAB
 - c. Jay R. Smith
 - d. Watts
 - e. Zurn.

2.2 CLEANOUTS

- A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - 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) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Drainage Products.
 - 6) Zurn Plumbing Products Group.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping

B. Metal Floor Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - 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) Josam Company.
 - 2) Oatey.
 - 3) Sioux Chief Manufacturing Co., Inc.
 - 4) Smith, Jay R. Mfg. Co.
 - 5) Tyler Pipe.
 - 6) Watts Drainage Products.
 - 7) Zurn Plumbing Products Group.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
5. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities.
 - e. Sioux Chief Manufacturing Company, Inc.
2. Body: PVC.
3. Closure Plug: PVC.
4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.
- 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Install expansion joints, if indicated, in roof drain outlets.
 3. Position roof drains for easy access and maintenance.
- B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate cleanouts 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 wall cleanouts in vertical conductors. Install access door in wall if indicated.
- F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- G. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- H. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 2. Copper Sheets: Solder joints of copper sheets.
- B. 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 the pipe size, with a minimum length of 10 inches and with 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.

- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. 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 22 14 23

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SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.
 - 2. Sump-pump basins and basin covers.

1.2 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.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 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.

1.5 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 MANUFACTURERS

- A. Submersible Pumps: Liberty, Zoeller, Little Giant, Grundfos, Hydromatic

2.2 SIMPLEX SUBMERSIBLE SUMP PUMPS

- A. Submersible, **Fixed-Position, Single-Seal** Effluent Pumps:
1. Description: Factory-assembled and -tested effluent-pump unit.
 2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump.
 3. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 4. Impeller: Statically and dynamically balanced, non-clogging vortex, closed or semi-open design for clear wastewater, and keyed and secured to shaft.
 5. Pump and Motor Shaft: Steel, with factory-sealed, grease-lubricated ball bearings.
 6. Seal: Mechanical.
 7. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
 8. 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: Oil.
 9. Float Switch Controls:
 - a. Enclosure: NEMA 250, **Type 1**; wall-mounted.
 - 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.

2.3 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.

2.4 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. Engage a factory-authorized service representative to 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 14 29

SECTION 22 33 00
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Flow-control, electric, tankless, domestic-water heaters.
 - 3. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water 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, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - b. Electric, Tankless, Domestic-Water Heaters: One year(s).
 - c. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

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. Bradford White
 - b. Lochinvar
 - c. Rheem
 - d. A.O. Smith, State.
2. Standard: UL 1453.
3. Storage-Tank Construction: ASME-code, steel horizontal arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 ELECTRIC, TANKLESS, domestic-WATER HEATERS

A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:

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. Bosch
 - b. Chonomite
 - c. Eemax
 - d. Stiebel Eltron.
2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
3. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Flow-control fitting.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
4. Support: Bracket for wall mounting.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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. Amtrol
 - b. A.O. Smith
 - c. Taco, State.
2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

- ### B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater and include drain

outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

- C. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- D. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- E. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- F. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- G. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- H. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases.
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.

2. Maintain manufacturer's recommended clearances.
 3. Arrange units so controls and devices that require servicing are accessible.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 8. Anchor domestic-water heaters to substrate.
- B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
1. Maintain manufacturer's recommended clearances.
 2. Arrange units so controls and devices that require servicing are accessible.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 5. Anchor domestic-water heaters to substrate.
- C. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with

requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

- H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- I. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- J. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- K. Fill electric, domestic-water heaters with water.
- L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters.

END OF SECTION 22 33 00

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this Section includes, but is not limited to:
1. Inclusion of all plumbing fixtures, complete and ready for use. All fixtures, except as otherwise specified, shall be constructed of vitreous china with all visible exposed surfaces glazed.
 2. Providing all stops, traps, escutcheons, connections, etc., as are necessary to complete the installation of each fixture, whether such items are listed or not.
 3. Plumbing Trim: All finished exposed faucets, traps, connecting piping, stops, flush valves and other fixture trim shall be chromium-plated brass unless otherwise specified and shall be supported rigidly to fixtures and to walls with matching brackets at not more than 2'-0" center. All fastenings shall be chromium-plated brass or may be 302 stainless steel if of matching color and finish. Faucets shall be furnished as required. Vacuum breakers shall be provided as a part of the fixture trim wherever there is a possibility of back-siphoning.
 4. Fixture Stops: Shut-offs for all fixtures shall be loose-key, lock-shield-type. All fixture stops shall be angle- or straight-type adapted for each particular location and shall be located immediately adjacent to the fixture. Use threaded adaptors when used in conjunction with copper tube work.
 5. All exposed screws or fasteners for plumbing fixtures and faucets shall be vandalproof. Contractor shall take care to coordinate this item with his suppliers prior to Shop Drawings submittal.
 6. Aerators, where required for sinks and lavatories shall be vandalproof

1.2 QUALITY ASSURANCE

- A. Meet the requirements of the following:
1. State Plumbing Code.
 2. State Department of Housing, Buildings and Construction.
- B. Material Standards
1. ANSI/ASME A112.19.2-90: Vitreous China Plumbing Fixtures.
 2. ANSI/ASME A112.19.3-87: Stainless Steel Plumbing Fixtures (Designed for Residential Use).
 3. ANSI/ASME A112.19.5-79: Trim for Water Closet Bowls, Tanks, and Urinals.
 4. ANSI/ASSE 1016-90: Performance Requirements for Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.
- C. ANSI/ASSE 1025-78: Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon-Type, Residential Applications.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. For flushometer valves and electronic sensors to include in operation and maintenance manuals.
 - 2. For lavatories and faucets to include in operation and maintenance manuals.
 - a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following: Servicing and adjustments of automatic faucets.
 - 3. For sinks to include in maintenance manuals.
 - 4. For shower faucets to include in maintenance manuals.
 - 5. For pressure water coolers to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 - 3. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no less than 1 of each.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

- 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. Plumbing Faucets: Chicago Faucet, American Standard, Kohler, Symmons, Speakman, and Moen.
 2. Vitreous China Plumbing Fixtures: American Standard, Kohler, Gerber.
 3. Utility Sinks: Fiat, Stern and Williams, Mustee.
 4. Closet Seats: Church, Sperzel, Bemis, Beneke, and Centoco.
 5. Shower Mixing Valves: Powers, Leonard, Lawler, and Bradley.
 6. Stainless Steel Sinks: Elkay, Just, Metcraft, and Southern Kitchens.
 7. Electric Water Coolers: Elkay, Haws, Oasis, and Halsey-Taylor.
 8. Precast Shower Receptacles: Fiat, Stern and Williams, Creative Industries.
 9. Prefabricated Showers: Fiat, Kohler, Aquaglass, Aquatic.
 10. Carriers: Josam, Smith, Wade, Watts, Zurn or Mifab.
- B. Plumbing Fixtures – General: Constructed or equipped with anti-siphon devices to prevent siphoning waste material into potable water supply system.
- C. Escutcheons and Plates: Conceal all holes where pipes pass through walls, floors or ceilings; use plates or escutcheons.
- D. Piping Exposed in Finished Areas (including fittings and trim): Chromium-plated or nickel-plated brass with polished bright surface.
- E. Trim for Lavatories and Sinks: Provide with renewable cartridges.
- F. Vitreous Caps: Provide for water closet bolts.
- G. Sealant: Silicone-type. See Division 07 Section “Joint Sealants”.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Water-Closet
 1. Installation:
 - a. Install level and plumb according to roughing-in drawings.
 - b. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
 - c. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
 2. Install toilet seats on water closets.

B. Lavatories

1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
 - a. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
3. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
4. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
5. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

C. Sinks

1. Install sinks level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-hung sinks.
 - a. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
3. Set floor-mounted sinks in leveling bed of cement grout.
4. Install water-supply piping with stop on each supply to each sink faucet.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 - b. Install stops in locations where they can be easily reached for operation.
5. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
6. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

D. Showers

1. Assemble shower components according to manufacturers' written instructions.
2. Install showers level and plumb according to roughing-in drawings.
3. Install water-supply piping with stop on each supply to each shower faucet.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 - b. Install stops in locations where they can be easily reached for operation.
4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
5. Set shower receptors or shower basins in leveling bed of cement grout.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Electric Water Coolers

1. Install electric water cooler level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
2. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
3. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
4. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
5. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. 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. "Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixture with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to fixtures, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust fixture and controls. Replace damaged and malfunctioning fixture

3.5 CLEANING AND PROTECTION

- A. Clean fixture and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

SECTION 23 00 00

HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general requirements applicable to all HVAC work.
- B. Provide complete and fully operational HVAC systems controlled as indicated.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, 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.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: As indicated in other Division 23 Sections.
 - 2. Shop Drawings: As indicated in other Division 23 Sections.
- B. Informational Submittals:
 - 1. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Building roofs, walls, and floors.

- b. Building structural components to which equipment, piping, ductwork, cables, and conduit will be attached.
- c. Suspended ceiling components.
- d. HVAC equipment, piping, ductwork, and controls.
- e. Size and location of access doors and panels installed in walls and inaccessible ceilings for products installed behind walls and requiring access.
- f. Items penetrating finished ceiling including the following:
 - 1) Luminaires.
 - 2) Air outlets and inlets.
 - 3) Ceiling-mounted devices including speakers, sensors, and WI-FI antennae.
 - 4) Sprinklers.
 - 5) Service access panels.

C. Closeout Submittals:

- 1. Operation and Maintenance Data: For HVAC systems and equipment to include in emergency, operation, and maintenance manuals. Provide data in pdf format on CD, DVD, or USB media.
- 2. Warranty documentation:
- 3. Record documentation:
- 4. Testing, adjusting and balancing report.
- 5. Start reports for all equipment.
- 6. Field reports, including ductwork leakage testing and piping pressure testing.
- 7. Valve tag charts.
- 8. Subcontractor contact list including name, phone number and email contact information.
- 9. Maintenance Items: Provide items specified in other Division 23 Sections packaged with protective covering for storage and identified with labels describing contents.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Where feasible, arrange for product delivery when construction has progressed enough to allow the products to be installed in their final locations. If lieu of the above, store products protected from weather and physical damage.
- B. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture into pipe.
- C. Do not allow any materials or equipment to be stored in standing water or exposed to the elements.
- D. Handle products carefully to prevent damage. Do not install damaged items; replace them with new items. If approved by the Engineer, items with minor damage may be repaired and installed.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, and openings in building structure during progress of construction, to allow for HVAC installation.
- B. Coordinate installation of required supporting devices and set sleeves in cast-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.
- D. New Equipment:
 - 1. All equipment items are to remain disabled and off unless TAB personnel are on-site actively testing the equipment.
 - 2. Utilization of the permanently installed HVAC systems to condition or pressurize the construction area is not allowed without prior specific written authorization from the Owner listing which equipment may be operated under what limiting conditions. Provide written agreement to compensate the Owner for utility usage.
- E. Provide transitions and fittings in ductwork and piping as well as extra lengths of ductwork and piping as required. Illustrate all such ductwork fittings on the sheet metal shop drawing submittal.
- F. Provide temporary connections to maintain service during construction.
- G. Identify required outages on the schedule and any temporary measures required.
- H. The Drawings indicate the general arrangement and scope of the systems and shall be followed insofar as possible. If deviations from the layout are necessitated by field conditions, submit detailed layouts of the proposed departures in writing to the Engineer for approval before proceeding with the work.
- I. The Drawings are schematic and are not intended to show every vertical and horizontal offset that may be necessary to complete the system or clear obstructions or the work of the other contractors. Contractors shall anticipate during bidding that additional offsets may be required and include same in their proposals.
- J. The Drawings and Specifications are complementary. Items appearing in the Specifications may not be indicated on the Drawings or vice-versa, but all shall be considered as part of the Contract and must be executed by the Contractor the same as though indicated by both. Clarify conflicting statements with the Engineer prior to submitting a bid.
- K. Measurements: Make your own measurements on site and be responsible for correct sizes. Coordinate this work with all other branches and trades in such a manner as to cause a minimum of conflict or delay. Coordinate your work in advance with all other trades and report immediately difficulties anticipated; propose solutions to resolve potential difficulties.

- L. Clearances: Install items to maintain maximum headroom and clearance around equipment. When space or headroom appear inadequate, notify the Engineer prior to proceeding with the installation. No claims for additional compensation due to failure on the part of the Contractor or his subcontractor to comply with this requirement will be approved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Where a specific manufacturer is listed on the Drawings, consider it as the Basis-of-Design.

2.2 ELECTRICAL REQUIREMENTS

- A. Electrical Characteristics for HVAC Equipment: Equipment with higher electrical power requirements may be furnished provided that such proposed equipment is approved in writing and that connecting electrical supply, wiring, overcurrent protection devices, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

2.3 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, non-gaseous, 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 EXAMINATION

- A. Examine work area and rough-in work before beginning installation.
- B. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Plan Work beforehand.
- B. Request explanation from the Engineer if the intent of the Drawings or Specifications is not clear.

3.3 INSTALLATION

- A. Install mechanical items in accordance with the Specifications and manufacturer's installation instructions.

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 site.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches horizontally 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 through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, 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.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Metal channel (strut) products in accordance with Metal Framing Manufacturers Association standards may be used for metal framing and anchorages.
- C. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- D. Field Welding: Comply with AWS D1.1.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting or weakening wood members.
- C. Attach to substrates as required to support applied loads.

3.7 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 contact 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 and level bearing surfaces for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom if 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. Maintain manufacturer's recommended service clearances. Maintain NFPA 70 required clearances to electrical components.
- D. Connect equipment for ease of disconnecting with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment to allow space for piping installed at required slope.

3.9 CLEANING AND RESTORATION

- A. Repair damage resulting from the execution of the Work.
- B. Leave the work area in broom clean condition or better at the end of each day.
- C. Thoroughly clean the work area at the completion of construction.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect mechanical equipment components, assemblies, and installations, including connections.
- B. Non-Conforming Work: Items will be considered defective if they do not pass tests and inspections.
- C. Reports: Prepare test and inspection reports for informational submittals.

3.11 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.12 STARTUP

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to startup mechanical equipment according to manufacturer's instructions.

3.13 DEMONSTRATION

- A. Engage factory-authorized service representatives to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Video record the training sessions and provide electronic copy to Owner.

END OF SECTION 23 00 00

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Rotor: Random-wound, squirrel cage.
- E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating.
- G. Insulation: Class F.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Grounding: Maintenance free, conductive micro-fiber shaft-grounding ring with a minimum of two rows of circumferential micro fibers to discharge shaft voltages away from the bearings to ground.
 - a. Motors 100 HP or Less: One shaft grounding ring installed either on the drive end or non-drive end.
 - b. Motors More Than 100 HP: Insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor.

- c. All Motors: Bonded from motor foot to system ground with high-frequency ground strap of flat braided, tinned copper with terminations to accommodate motor foot and system ground connections.

- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Motor: Brushless permanent magnet DC motor.
- B. Control: Integral control module to convert AC power to DC power and to generate three-phase signal to direct motor speed. Motor speed adjustment through 0-10 V DC input.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

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SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers, saddles, and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment.

1.4 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product indicated.

2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Metal framing systems.
 - c. Fiberglass strut systems.
 - d. Pipe stands.
 - e. Equipment supports.

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

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

C. Informational Submittals:

1. Welding certificates.

D. Closeout Submittals:

1. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

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

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

C. SMACNA.

D. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

E. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.

1. B-line Systems, Inc; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. ERICO/Michigan Hanger Co.
4. Globe Pipe Hanger Products, Inc.
5. Grinnell Corp.
6. Hilti North America.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.

B. Carbon-Steel Pipe Hangers and Supports:

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

C. Saddles

1. Material Galvanized Steel, 180-degree shape, each saddle marked with insulation O.D. Standard manufacturers gauge per insulated pipe size.

D. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO International Corporation.
 - 3. National Pipe Hanger Corporation.
 - 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig, or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

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

2.5 EQUIPMENT SUPPORTS

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

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:

1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match outside diameter of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems, and stainless-steel or corrosion-resistant attachments for hostile environment applications.

- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.

- c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

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SECTION 23 05 48.13

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes vibration isolation devices for HVAC.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
 - a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
2. Shop Drawings:
 - a. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Delegated-Design Submittal: For each vibration isolation device.
 - a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

B. Informational Submittals:

1. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
2. Qualification Data: For testing agency.
3. Welding certificates.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties.
 - 5. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - 6. Infused nonwoven cotton or synthetic fibers.
 - 7. Load-bearing metal plates adhered to pads.
 - 8. Sandwich-Core Material: Resilient.

2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
 - 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top housing with attachment and leveling bolt.

2.6 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig isolation material providing equal isolation in all directions.

2.9 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.11 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.12 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Novia; A Division of C&P.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.13 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Novia; A Division of C&P.
 4. Pate Company, The.
 5. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.

- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter flashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 3 Sections.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 3 Sections.

END OF SECTION 23 05 48.13

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Warning tags.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
2. Samples: For color, letter style, and graphic representation required for each identification material and device.
3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number where equipment is specified.

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

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

B. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.6 WARNING TAGS

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

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve or control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Refrigerant Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.5 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold-air supply ducts.
 - 2. Yellow: For hot-air and variable temperature supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
- C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing air systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Certified TAB reports.
- B. Informational Submittals:
 - 1. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 - 2. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
 - 3. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB contractor and certified by AABC or NEBB as a TAB technician.
- B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard AABC or NEBB TAB forms.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 COORDINATION

A. Notice: Provide at least seven days' notice before each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.6 HVAC CONTRACTOR RESPONSIBILITIES

A. Provide TAB agency one complete set of contract documents, change orders, and approved submittals in digital pdf format.

B. Control contractor shall provide required BAS hardware, software, personnel, and assistance to TAB agency as required for TAB agency to balance the systems. Control contractor shall also provide trending reports as needed to demonstrate that systems are complete.

C. Coordinate meetings and assistance from suppliers and contractors as required by TAB agency.

D. Provide additional valves, dampers, sheaves and belts as required by TAB agency.

E. Flag all manual volume dampers with high-visibility tape.

F. Provide access to all dampers, valves, test ports, nameplates, and other appurtenances as required by TAB agency.

G. Remove and replace or repair insulation as needed to provide access for the TAB work.

H. Have the HVAC systems at complete operational readiness before TAB begins.

I. Promptly correct deficiencies identified during TAB.

J. Maintain a construction schedule that allows the TAB agency to complete work prior to occupancy.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC systems and equipment controls.
- E. Examine plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenums are sealed (and fire-stopped if required).
- F. Examine equipment performance data including fan ~~and pump~~ curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that might cause reduced capacities.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment under actual installed conditions. Use tables and charts in AMCA 201, "Fans and Systems" or in SMACNA "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, clean filters are installed, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, verifying that they are accessible and that their controls are connected, configured by the control contractor, and functioning.
- K. Examine all equipment items to verify correct piping arrangements.
- L. Examine heat-transfer coils for correct piping connections and for clean and properly-spaced fins.

- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for each equipment item.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. General:
 - a. Electrical power wiring is complete.
 - b. Control systems are operational.
 - c. Access is provided to balancing and control devices.
 - d. Variable frequency drive start-up procedures are complete.
 - e. Safety devices are operational and indicating normal status.
 - 2. Air Side:
 - a. Ductwork is complete with air terminals installed.
 - b. Balance, fire, and smoke dampers are open and operational.
 - c. Control dampers are in their normal (fail) positions.
 - d. Equipment and duct access doors are securely closed.
 - e. Clean filters are installed.
 - f. Fans are operating and rotating in correct directions.
 - g. Fan vibration levels are within tolerance limits.
 - h. Building envelope is complete, and exterior windows and doors are closed.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC "National Standards for Total System Balance" or NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 2. Install new insulation where insulation is removed for TAB to match removed materials. Restore insulation, coverings, vapor barrier, and finish.

- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control devices, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of system "as-built" duct layouts with all components identified.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check condensate drains for proper connections and function.
- H. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AND VARIABLE-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow as follows:
 - a. Set outdoor air, return air, and relief air dampers for proper positions that simulate minimum outdoor air conditions.
 - b. Where conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where conditions are not suitable for duct Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Where sufficient space is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Measure fan static pressures as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the discharge flexible connection.

- c. Measure inlet static pressure of single-inlet fan at the fan inlet or through the inlet flexible connection.
 - d. Measure inlet static pressure of double-inlet fan through the wall of the plenum that houses the fan or through the inlet flexible connections.
 3. Measure static pressure across each component that makes up the air-handling unit, rooftop unit, or other air-handling equipment. Report the cleanliness status of filters and the time static pressures are measured. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 4. Adjust fan speed higher or lower than indicated speed as needed to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for ducts to indicated airflows within specified tolerances.
 1. Measure airflows of branch ducts.
 2. Adjust branch duct balance dampers for specified airflows.
 3. Re-measure each branch duct after all have been adjusted.
- C. Adjust air outlets and inlets for each space to indicated airflows.
 1. Adjust each outlet in same room or space to indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
 3. Measure airflows at all inlets and outlets.
 4. Adjust each inlet and outlet for specified airflow.
 5. Re-measure each inlet and outlet after all have been adjusted.
- D. Verify final system conditions.
 1. Re-measure and confirm minimum outdoor air, return air, and relief air flow rates are within design tolerances. Readjust as necessary.
 2. Re-measure and confirm total airflow is within design tolerance.
 3. Re-measure all final fan operating data. Include fan speeds, motor voltages, motor amperages, and static profiles.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation; adjust if necessary. Measure and record all operating data.
 6. Record final performance data.

3.6 ADDITIONAL PROCEDURES FOR VARIABLE- VOLUME AIR SYSTEMS

- A. Variable-Air-Volume Systems: Adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Verify that the duct static pressure sensors are installed and controlling the system.
3. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure inlet static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so terminal unit is calling for maximum airflow. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor. When maximum airflow is correct, balance the air outlets downstream from the terminal unit.
 - b. Adjust controls so terminal is calling for minimum airflow. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. Note any deviation from design airflow.
5. After all terminal units have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by the fan manufacturer.
 - a. Set outdoor air, return air, and relief air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflows so connected total matches fan selection and simulates actual load in the building.
6. Measure fan static pressure. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outdoor airflow rates to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return air ducts and inlets as described for constant-volume air systems.
 - b. Verify all terminal units are meeting design airflow rates under system maximum airflow conditions.
8. Re-measure the inlet static pressure at the most critical air terminal unit and adjust the system static pressure setpoint to the most energy-efficient setpoint to maintain optimum system static pressure. Record setpoint.
9. Re-measure the final system conditions as follows:
 - a. Re-measure and confirm minimum outdoor air, return air, and relief air flow rates are within design parameters. Readjust to design if necessary.
 - b. Re-measure and confirm total airflow rates are within design parameters.
 - c. Re-measure all final fan operating data.

- d. Mark all final settings.
- e. Test system in economizer mode. Verify proper operation and adjust, if necessary. Measure and record all operating data.
- f. Verify tracking between supply and return fans.
- g. Record final performance data.

3.7 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Other Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.

3.8 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into a separate section for each tested and balanced system. Provide a final report that is a complete record of the HVAC system performance, including conditions of operation, any outstanding items, and any deviations found during the testing and balancing process. The final report is to provide a reference of actual operating conditions for the owner and operations personnel. All measurements and test results that appear in the report must be made on site and dated by the responsible technician or test and balance engineer.
- B. As a minimum the report shall include the following information:
 1. Title page, including:
 - a. TAB company name, address, and telephone number.
 - b. Project name, client, identification number, and location.
 - c. Project architectural firm, address, and telephone number.
 - d. Project HVAC engineering firm, address, and telephone number.
 - e. Project HVAC contracting firm, address, and telephone number.
 - f. TAB certification statement.
 - g. Test and balance engineer name, signature, and certification number.
 - h. Report date.
 2. Table of contents.
 3. TAB national performance guarantee.
 4. Report summary, including:
 - a. List of items that do not meet specified tolerances.
 - b. Information that may be considered in resolving deficiencies.
 5. Instrument list, including:
 - a. Type.
 - b. Manufacturer.
 - c. Model.
 - d. Serial number.

e. Calibration date.

C. TAB test data for all systems included in the Work.

END OF SECTION 23 05 93

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SECTION 23 07 13

HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes duct insulation and appurtenances.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. 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.

1.4 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.
- B. Protection: Do not permit mineral fiber insulation to get wet. Mineral fiber insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with duct Installer for duct insulation application. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. 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.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Properties:
 - a. Maximum Operating Temperature: 180 deg F.
 - b. Minimum Operating Temperature: -70 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
 - d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
 - e. Maximum Water Absorption by Volume: 0.2%.
- F. Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin in a flexible blanket. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with

factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Atmosphere Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR Duct Wrap FRK.
2. Properties:
 - a. Maximum Operating Temperature: 250 deg F.
 - b. Maximum Compressed Thermal Conductivity at 75 deg F Mean Temperature:
 - 1) Density 0.75 PCF: 0.29 Btu-in/hr-ft²-deg F.
 - 2) Density 1.0 PCF: 0.27 Btu-in/hr-ft²-deg F.
 - 3) Density 1.5 PCF: 0.24 Btu-in/hr-ft²-deg F.

G. Board Insulation: Mineral or glass fibers bonded with a thermosetting resin in a semi-rigid board. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. CertainTeed Corp.; CertaPro Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Earthwool Insulation Board.
 - d. Manson Insulation Inc.; AK Board.
 - e. Owens Corning; Fiberglas 700 Series.
2. Properties:
 - a. Maximum Operating Temperature: 450 deg F.
 - b. Minimum Operating Temperature: 0 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature:
 - 1) Density 3.0 PCF: 0.23 Btu-in/hr-ft²-deg F.
 - 2) Density 6.0 PCF: 0.23 Btu-in/hr-ft²-deg F.
 - d. Minimum Compressive Strength at 10% Deformation:
 - 1) Density 3.0 PCF: 25 lb/ft².

- 2) Density 6.0 PCF: 200 lb/ft².

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. For indoor applications, adhesives shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 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. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 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 F.
 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.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.5 SEALANTS

- A. 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.
- B. ASJ Flashing Sealants, 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.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system specifications indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. All-Service Jacket (ASJ): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
 - 2. All-Service Jacket – Self-Sealing Lap (ASJ-SSL): ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.

3. Foil-Scrim Kraft (FSK) Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Maximum water vapor permeance 0.02 perms.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as indicated; roll stock ready for shop or field cutting and forming. Adhesive as recommended by jacket material manufacturer.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Johns Manville; Ceel-Co or Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Color: White unless indicated otherwise.
- D. Self-Adhesive Indoor or Outdoor Jacket: Multiple-ply laminated vapor barrier and waterproofing membrane for installation over insulation; consisting of aluminum, Tedlar, or laminate sheet with integral acrylic peel-and-stick adhesive with white, silver, or black facing as indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. 3M; VentureClad.
 - b. Polyguard Products, Inc.; Alumaguard 60.

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.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation in accordance with manufacturers' instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- C. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Slope outdoor insulation on top of flat surfaces to prevent water pooling.
- H. Keep insulation materials dry during application and finishing. Mineral fiber insulation that is or has been wet shall be removed from the job site.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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 insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- M. 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 on center
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- O. Repair joint separations and cracking due to thermal movement.
- P. 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.

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 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.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- E. Insulation Installation at Floor Penetrations:
 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket or Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to all surfaces of ducts, fittings, and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. For board insulation, groove and score insulation to fit to outside and inside radii of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

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; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. 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 on center 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 painting specifications.

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

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

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

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

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

3.9 INDOOR DUCT INSULATION SCHEDULE

- A. Supply air, concealed from view, round or oval, duct insulation:

- 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

- B. Supply air, exposed to view in unfinished space, round or oval, duct insulation:

- 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

- C. Supply air, concealed from view, rectangular, duct insulation:

- 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

- D. Supply air, exposed to view in unfinished space, rectangular, duct insulation:

- 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

- E. Supply air, exposed to view in finished space, rectangular, duct insulation:

1. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density with 20 mil PVC jacket or finish-painted ASJ.
- F. Return air or mixed air, concealed from view, round or oval, duct insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- G. Return air or mixed air, exposed to view in unfinished space, round or oval, duct insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- H. Return air or mixed air, exposed to view in finished space, round or oval, duct insulation: None.
- I. Return air or mixed air, concealed from view, rectangular, duct insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- J. Return air or mixed air, exposed to view in unfinished space, rectangular, duct insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- K. Return air or mixed air, exposed to view in finished space, rectangular, duct insulation:
1. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density with 20 mil PVC jacket or finish-painted ASJ.
- L. Relief air or transfer air, any indoor location, duct insulation: None unless lined for acoustics.
- M. Outdoor air or combustion air, concealed from view, round or oval, duct insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- N. Outdoor air or combustion air, exposed to view in unfinished space, round or oval, duct insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- O. Outdoor air or combustion air, exposed to view in finished space, round or oval, duct insulation:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density with 20 mil PVC jacket.

P. Outdoor air or combustion air, concealed from view, rectangular, duct insulation:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

Q. Outdoor air or combustion air, exposed to view in unfinished space, rectangular, duct insulation:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

R. Outdoor air or combustion air, exposed to view in finished space, rectangular, duct insulation:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density with 20 mil PVC jacket or finish-painted ASJ.

3.10 OUTDOOR DUCT INSULATION SCHEDULE

A. Provide watertight external jacket completely enclosing all external duct insulation on all ducts installed outdoors (other than preinsulated ducts).

B. Supply air, round or oval, duct insulation:

1. Flexible Elastomeric: 2 inches thick.

C. Supply air, rectangular, duct insulation:

1. Flexible Elastomeric: 2 inches thick.

D. Return air or mixed air, round or oval, duct insulation:

1. Flexible Elastomeric: 2 inches thick.

E. Return air or mixed air, rectangular, duct insulation:

1. Flexible Elastomeric: 2 inches thick.

F. Relief air or transfer air, any outdoor location, duct insulation: None.

G. Outdoor air or combustion air, any outdoor location, duct insulation: None.

H. Exhaust air (all classes), any outdoor location, duct insulation: None unless indicated otherwise.

I. Exhaust air (class 2 exhaust from shower or washdown area), any outdoor location, duct insulation:

1. Flexible Elastomeric: 2 inches thick.

END OF SECTION 23 07 13

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating HVAC piping systems.

1.2 SUBMITTALS

- A. Action Submittals

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

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting 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.

1.4 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.
- B. Protection: Do not permit mineral fiber or calcium silicate insulation to get wet. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with piping Installer for piping insulation application.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. 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.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Outdoor installations shall be provided with a UV protective coating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Properties:
 - a. Maximum Operating Temperature: 180 deg F.
 - b. Minimum Operating Temperature: -70 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
 - d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
 - e. Maximum Water Absorption by Volume: 0.2%.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

2.3 SEALANTS

- A. 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.

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.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. 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 in accordance with manufacturers' instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, and thicknesses required for each item of pipe system.

- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- 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.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- M. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. 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.

- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. 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 firestopping section.

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, and Unions:
 - 1. Install insulation over fittings, 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FINISHES

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

3.8 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate or Equipment Drain Water Below 60 Deg F, or Makeup Water:

1. NPS 1-1/4 or Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1/2 inch thick.

B. Refrigerant Suction:

1. NPS 3/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
2. NPS 1 to NPS 6: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

C. Refrigerant Hot-Gas:

1. NPS 1-1/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
2. NPS 1-1/2 or Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.

3.9 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction:

1. NPS 3/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
2. NPS 1 to NPS 6: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.

B. Refrigerant Hot-Gas:

1. NPS 1-1/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.
2. NPS 1-1/2 or Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 2-1/2 inches thick.

END OF SECTION 23 07 19

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes third party commissioning process requirements for HVAC&R systems, assemblies, and equipment.

1.2 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 SUBMITTALS

- A. Informational Submittals:
 - 1. Certificates of readiness.
 - 2. Certificates of completion of installation, pre-start, and startup activities.

1.4 INSTRUMENTATION, TOOLS AND EQUIPMENT COSTS

- A. The contractor is responsible for and shall include all labor, instrumentation, tools, and equipment costs required to perform the pre-functional, functional, owner training, and the development of all project manuals.

1.5 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. Attend commissioning team meetings held on a variable basis throughout the project's construction phase.
- B. Complete the pre-functional construction checklists after work is completed.

- C. Perform functional commissioning tests at the direction of the CxA.
- D. Attend construction phase controls coordination meeting.
- E. Attend testing, adjusting, and balancing review and coordination meeting.
- F. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- G. Provide information requested by the CxA for final commissioning documentation.
- H. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- I. Address commissioning comments made the CxA on the Issues Log.

1.6 CxA'S RESPONSIBILITIES

- A. Provide project-specific pre-functional and functional construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct the functional commissioning testing.
- C. Verify testing, adjusting, and balancing (TAB) of all tested systems are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan and Systems Manual:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FUNCTIONAL TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.
- H. The contractor shall provide a written document (to the CxA) identifying all of the changes and deviations from the sequence of operation, approved by the Engineer of Record and Owner, listed in the design documents at least one week prior to the commencement of functional testing.

3.2 TESTING AND BALANCING VERIFICATION

- A. Provide copies of reports, sample forms, checklists, and certificates to the CxA for review.
- B. Notify the CxA at least 14 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide TAB technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing contractor 14 days in advance of the date of field verification. Notice will not include data points to be verified and will be selected by the commissioning agent and owner.

2. The testing and balancing contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.
- D. The TAB Contractor shall be on site and available for five (5) days as part of the system functional testing. The TAB Contractor shall participate in verification of the functional commissioning checklist as directed by the CxA.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform functional commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Controls Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 "Instrumentation and Control for HVAC" and "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- B. Pipe system cleaning, tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, and testing plan. Provide cleaning, and testing plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
- C. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- F. The following systems will be commissioned as part of this project:
 - 1. All common area Air Handling Units and Exhaust Fans.
 - 2. 25% of all Apartment Air Handling Units and Exhaust Fans.
 - 3. Rooftop and DOAS Unit.
 - 4. Split systems and Ductless Split Systems.

END OF SECTION 23 08 00

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SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pipe and fittings for hydronic piping.

1.2 SUBMITTALS

- A. Action Submittals:

- 1. Product Data: For each type of the following:

- a. Pipe.
 - b. Fittings.
 - c. Joining materials.

- 2. Delegated-Design Submittal:

- a. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, and foundation walls.

- B. Informational Submittals:

- 1. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

- 1. Condensate-Drain Piping: 50 psig and 150 deg F.

2.2 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.

- 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

- B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
 - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.3 JOINING MATERIALS

- A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- B. Solvent Cements for CPVC Piping: ASTM F 493. Solvent cement VOC content 490 g/L or less. Adhesive primer VOC content 550 g/L or less.
- C. Solvent Cements for PVC Piping: ASTM D 2564. Primer ASTM F 656. Solvent cement VOC content 510 g/l or less. Adhesive primer VOC content 550 g/L or less.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Condensate-Drain Piping: PVC or CPVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping a maximum of 2 feet above accessible ceilings or enough to allow sufficient space for ceiling panel removal.
- E. Install piping to permit equipment and valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Comply with requirements in other Division 23 Sections for identifying piping.
- I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in other Division 23 Sections.

- J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in other Division 23 Sections.
- K. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in other Division 23 Sections.

3.3 HANGERS AND SUPPORTS

- A. Comply with requirements in other Division 23 Sections for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions and local codes. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

3.4 PIPE JOINT CONSTRUCTION

- A. 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, 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.

END OF SECTION 23 21 13

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SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tubes.
 - 2. Fittings.
 - 3. Joining Materials.
 - 4. Specialties.

1.2 REFERENCES

- A. ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- B. The American Society of Mechanical Engineers (ASME) Publications:
 - 1. "Boiler and Pressure Vessel Code"
 - 2. B16.22 "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings"
 - 3. B31.5 "Refrigeration Piping and Heat Transfer Components"
- C. ASTM International (ASTM) Publications: (Former American Society for Testing and Materials)
 - 1. B88 "Standard Specification for Seamless Copper Water Tube"
 - 2. B280 "Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service"
- D. American Welding Society (AWS) Publications:
 - 1. A5.8 "Specification for Filler Metals For Brazing And Braze Welding"
- E. Manufacturers Standardization Society of the Valve and Fittings Industry. (MSS) Publications:
 - 1. SP-69 "ANSI/MSS Edition Pipe Hangers and Supports - Selection and Application"
- F. Underwriter's Laboratories, Inc. (UL) Standards:
 - 1. 207 "Standard for Refrigerant-Containing Components and Accessories, Nonelectrical"
 - 2. 429 "Standard for Electrically Operated Valves"

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 - 1. Product Data for each valve type and refrigerant piping specialty specified.
 - 2. Refrigerant piping indicated is schematic only. Contractor shall size and design the piping configuration and install the piping, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and conformance with warranties of connected equipment.
 - 3. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.
 - 4. Maintenance data for refrigerant valves and piping specialties to include in the operation and maintenance manual specified in Division 01 Sections.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Qualify brazing and welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with provisions of the following codes:
 - 1. ASME B31.5, "Refrigeration Piping."
 - 2. ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Non-electrical"; or UL 429, "Electrically Operated Valves."
- D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers:
 - 1. Refrigerant Valves and Specialties:
 - a. Henry Pratt Company, Subsidiary of Mueller Water Products, Inc.
 - b. Parker-Hannifin Corporation; Refrigeration & Air Conditioning Division
 - c. Sporlan Valve Company

2.2 TUBES

- A. Use pre-charged tubing where possible.
- B. Soft Copper Tube: ASTM B280, Type ACR, annealed temper.

2.3 TUBE FITTINGS

- A. Copper Fittings: ASME B16.22, wrought-copper streamlined pattern.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

2.5 REFRIGERANT PIPING SPECIALTIES

- A. Moisture/Liquid Indicators: 500-psig operating pressure, 200 deg F operating temperature; forged-brass body, with replaceable, polished, optical viewing window with color-coded moisture indicator, and solder-end connections.
- B. Permanent Filter-Dryer: 350-psig maximum operating pressure, 225 deg F maximum operating temperature; steel shell, and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for compliance with requirements for installation tolerances and other conditions affecting performance of refrigerant piping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Above ground, within Building: Type ACR drawn-copper tubing.

3.3 INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Install piping in short and direct arrangement, with minimum number of joints, elbows, and fittings.
- C. Arrange piping to allow normal inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- D. Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation. Maximum fill: 40%
- E. Insulate suction lines.
 - 1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

- F. Install branch lines to parallel compressors of equal length, and pipe identically and symmetrically.
- G. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- H. Slope refrigerant piping as follows:
 - 1. Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
 - 2. Install traps and double risers where indicated and where required to entrain oil in vertical runs.
 - 3. Liquid lines may be installed level.
- I. Use fittings for changes in direction and branch connections.
- J. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- K. Reduce pipe sizes using eccentric reducer fittings installed with level side down.
- L. Provide bypass around moisture-liquid indicators in lines larger than 2-inch NPS (DN50).
- M. Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.
- N. Install refrigerant valves according to manufacturer's written instructions.
- O. When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.
- P. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.
- Q. Charge and purge systems, after testing, dispose of refrigerant following ASHRAE 15 procedures.

3.4 HANGERS AND SUPPORTS

- A. General: Hangers, supports, and anchors are specified in Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in ASTM B88.
 - 1. 1/2 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. 5/8 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. 1 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 4. 1-1/4 Inches: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 5. 1-1/2 Inches: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.5 PIPE INSULATION

- A. Piping insulation is specified in Section 23 07 19 "HVAC Piping Insulation".

3.6 SPECIALTIES APPLICATION AND INSTALLATION

- A. Install permanent filter dryers in low-temperature systems using hermetic compressors, and before each solenoid valve.

3.7 PIPE JOINT CONSTRUCTION

- A. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

3.8 VALVE INSTALLATIONS

- A. Install refrigerant valves according to manufacturer's written instructions.

3.9 CONNECTIONS

- A. Electrical: Conform to applicable requirements of Division 26 Sections for electrical connections.

3.10 FIELD QUALITY CONTROL

- A. Inspect and test refrigerant piping according to ASME B31.5, Chapter VI.
 - 1. Pressure test with nitrogen to 200 psig. Perform final tests at 27-psig vacuum and 200 psig using halide torch or electronic leak detector. Test to no leakage.
- B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- C. Repair leaks using new materials; retest.

3.11 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Charge system using the following procedures:
 - 1. Install core in filter dryer after leak test, but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump until temperature of 35 deg is indicated on vacuum dehydration indicator.
 - 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.

5. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
6. Complete charging of system, using new filter-dryer core in charging line.
Provide full-operating charge.

END OF SECTION 23 23 00

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal ducts and fittings.
2. Sheet metal materials.
3. Round or rectangular duct connection systems.
4. Sealants and gaskets.
5. Hangers and supports.
6. Double-wall round and flat-oval ducts and fittings.

B. Related Requirements

1. ANSI/SMACNA 006-2006 (SMACNA 006) HVAC Duct Construction Standards – Metal and Flexible Third Edition. All ductwork shall be in conformance with this standard.
2. Structural Performance: Duct hangers, supports, and seismic restraints (where applicable) shall withstand the effects of gravity, wind, and seismic loads and stresses within limits and under conditions described in SMACNA 006, ASCE/SEI 7, and local requirements.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.2 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the Architect/Engineer. Accompany requests for layout modifications with calculations showing the proposed layout will provide original design results without increasing system total pressure.
- B. Duct sizes shown on the drawings indicate the internal dimensions of the ductwork.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of the following products:

- a. Prefabricated ductwork and fittings.
 - b. Liners and adhesives.
 - c. Rectangular duct connection systems.
 - d. Sealants and gaskets.
 - e. Seismic-restraint devices.
2. Shop Drawings:
- a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - b. Fittings, including details of construction.
 - c. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - d. Elevations of top and bottom of ducts along with applicable elevations of structural elements.
 - e. Dimensions of main duct runs from building grid lines.
 - f. Reinforcement and spacing.
 - g. Duct material and gauge thickness by pressure class.
 - h. Seam and joint construction.
 - i. Penetration details through fire-rated, smoke barriers and other rated partitions.
 - j. Equipment installation based on equipment being utilized on this project.
 - k. Duct accessories, including dampers, turning vanes, and duct access doors.
 - l. Length of application of acoustic duct liner where it will be applied.
 - m. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
 - n. Other systems installed in the same space as ducts where order of installation affects access.
 - o. Ceiling and wall mounted access doors and panels required to provide access to dampers, controls and other operating devices.
 - p. Ceiling mounted items, including light fixtures, diffusers, grilles, speakers, smoke detectors, sprinklers, other electrical devices, equipment and building structural members.
 - q. On each drawing, include a tabular list of each fan system's ductwork represented on that drawing and the total square foot surface area of each fan's duct system illustrated on the drawing.
 - r. Shop drawings shall be submitted prior to the fabrication or installation of the ductwork and serve as the foundation for coordination between various trades to maintain required ceiling heights.
3. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
- a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Failed test results and corrective action taken to achieve requirements.
- B. Leakage Testing Documentation: Contractor shall submit a written report to the authority having jurisdiction in which ducts designed at static pressures more than 3" wg pressure class (or as indicated) have been leak tested and that the air leakage

class is less than 6.0 per the Energy Code (or as indicated). Provide duplicate submittal to the Owner and the Engineer.

1.4 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for steel hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum hangers and supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance: Applicable requirements in:

1. NFPA 90A.
2. NFPA 90B.
3. NFPA 96.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Damage: Handle, transport, and store ducts to avoid damage. Damaged ductwork is not acceptable.

B. Protection: Protect ducts from mechanical damage, weather, and exposure to chemicals (including road salt). Do not permit insulation materials to get wet under any circumstances. Remove insulation that is or has been wet from the project site, and replace the insulation with undamaged new materials.

C. Ductwork and associated components shall be stored on blocking in a clean dry area to prevent damage and to prevent the entrance of dirt, debris, foreign matter and moisture.

D. Ductwork shall be adequately supported during storage to prevent sagging or bending.

E. Provide temporary storage, delivery and handling in accordance with SMACNA Duct Cleanliness for New Construction Guidelines, Intermediate Level.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA 006 based on indicated static-pressure class. The figure numbers below reference that standard.

1. Transverse Joint: Figure 2-1.
2. Longitudinal Seam: Figure 2-2.
3. Pressure Class Gage and Reinforcement: Table 2-1 through Table 2-52 and Figure 2-3 through Figure 2-18.
4. Elbow: Figure 4-2 (Use the following types only unless specifically approved by the Engineer.):
 - a. Type RE 1 (radius elbow).
 - b. Type RE 2 (square throat elbow with turning vanes).
 - c. Type RE 3 (radius elbow with vanes).
 - d. Type RE 5 (dual radius elbow).
 - e. Type RE 6 (mitered elbow without turning vanes) only for angles not greater than 45 degrees.
5. Turning Vanes: Figures 4-3 and 4-4. Figure 4-9 short radius vanes in accordance with Chart 4-1 are acceptable.
6. Branch Connection:
 - a. Diverging Flow: Figure 4-5 (all types). Figure 4-6 (following types only):
 - 1) 45-degree entry to rectangular branch.
 - 2) 45-degree lead-in to round branch.
 - 3) Conical connection.
 - 4) Bellmouth connection.
 - 5) Conical or bellmouth spin-in fitting only for pressure class 2" WG or less.
 - b. Converging Flow: Figure 4-5 (all types) and Figure 4-6 (all types). Conical or bellmouth spin-in fitting is acceptable only for pressure class 2" WG or less.
7. Offset, Transition, or Obstruction: Figure 4-7 (all types) and Figure 4-8 (Figure B and C). Do not use Figure 4-8 Figure A (pipe through duct), Figure D (mitered offsets around obstruction, or Figure E (split duct around obstruction) unless specifically approved by the Engineer.

2.2 SINGLE-WALL ROUND OR FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA 006 Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Eastern Sheet Metal.
 - b. FlaktGroup SEMCO.
 - c. Lindab Inc.
 - d. McGill AirFlow LLC.
 - e. Sheet Metal Connectors, Inc.

2. Transverse Joint: Figure 3-1 (all types).
3. Longitudinal Seam: Figure 3-2 (all types). Do not use type RL-5 (grooved seam pipe lock or flat lock), RL-6 (snaplock), RL-7 (snaplock), or RL-8 (snaplock) seam for duct over 1" WG pressure class. Fabricate round duct larger than 90-inch diameter with butt-welded longitudinal seam.
4. Pressure Class Gage and Reinforcement: Table 3-2 through Table 3-15 and Figure 3-3.
5. Elbow: Figure 3-4. Use centerline radius of 1.5 diameters for each elbow unless space constraints prevent a radius that large; in that event, the radius may be reduced to that indicated in Table 3-1 with mitered segments. If space constraints prevent a radius as large as indicated in Table 3-1, a mitered elbow with turning vanes similar to Figure 4-3 and Figure 4-4 may be used. Do not use an adjustable elbow for duct over 1" WG pressure class.
6. Branch Connection with Diverging or Converging Flow: Figure 3-5 and Figure 3-6. All types are acceptable for pressure class 2" WG or less duct. For pressure class 3" WG or more duct, use 90-degree tee fitting with oval-to-round tap, 45-degree lateral fitting, conical fitting, or wye fitting. Reducers may be incorporated into the fitting. Use only factory-fabricated fittings, not saddles or field-fabricated taps, for pressure class 3" WG or more duct.
7. Offset, Transition, or Obstruction: Figure 4-7 and Figure 4-8 modified for round or flat oval duct. Do not use Figure 4-8 Figure A (pipe through duct), Figure D (mitered offsets around obstruction), or Figure E (split duct around obstruction) unless specifically approved by the Engineer.
8. Flat Oval: Figure 3-7 and applicable figures for equivalent round duct.

2.3 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements,
 1. Lindab Inc.
 2. McGill AirFlow LLC.
 3. SEMCO Incorporated.
 4. Sheet Metal Connectors, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.
- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA 006 for material thicknesses and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90 unless otherwise indicated.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 or G90.
 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils on sheet metal surface of ducts and fittings exposed to corrosive conditions and minimum 1 mil on opposite surface.
 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts, listed and labeled for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated.
- F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Reinforcement Shapes and Plates:
1. Steel Duct: ASTM A 36/A 36M, steel plates, shapes, and bars; black or galvanized.
 2. Aluminum Duct: ASTM B209 alloy 6061-T6 members or steel members isolated from the aluminum with butyl rubber, neoprene, or EPDM gasket materials.
 3. Other Duct Materials: Reinforcement materials compatible with the duct materials at contact points.
- H. Tie Rods: Materials compatible with duct materials. Galvanized steel or stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 RECTANGULAR DUCT CONNECTION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Ductmate Industries, Inc.
 2. Hart & Cooley, Inc. Ward Industries.
 3. McGill Airflow LLC.
- B. Connection System: Rectangular duct transverse joint connection, reinforcement, and sealing system with roll-formed metal flanges, metal corner pieces, sealants, gaskets, and cleats.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a flame-spread index no greater than 25 and a smoke-

developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Sealant: Modified styrene acrylic.
3. Water resistant.
4. Mold and mildew resistant.
5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
6. Service: Indoor and outdoor.
7. Service Temperature: Minus 40 to plus 200 deg F.
8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
9. For indoor applications, sealant with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). For school projects, sealant complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). For school projects, sealant complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts or other materials compatible with duct materials.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods; galvanized rods with threads painted with zinc-chromate primer after installation; or stainless steel all-thread rods and nuts.
- C. Strap and Rod Sizes: Comply with SMACNA 006 Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Cables:
 - 1. Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
 - 2. Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
 - 3. End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Structural shapes and plates of materials compatible with duct materials and environmental conditions. Support material shall match duct construction material.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION GENERAL REQUIREMENTS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction losses for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings or Coordination Drawings.
- B. Install ducts according to SMACNA 006 unless otherwise indicated.

- C. Unless otherwise indicated, install ducts vertically plumb or horizontally level, and parallel and perpendicular to building lines. Avoid diagonal runs to maximum extent possible.
- D. Install ducts with a minimum clearance of 2 inch plus allowances for insulation thickness and access requirements.
- E. Cable hangers may only be used on low pressure (2" wg construction and lower) round spiral ductwork which is not insulated and has a diameter 10" or less. Utilize the double lock method such that the lower loop is clinched tight to the ductwork and the cable is vertical. Utilize manufacturer's top attachment device.
- F. Provide duct offsets needed to avoid interferences with structure, finishes, piping, other ducts, conduit, etc. Coordinate the work with all trades to minimize such offsets. Install ducts with fewest joints possible.
- G. Do not penetrate ducts with conduit or piping.
- H. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- I. Secure couplings with sheet metal screws. Install screws at maximum intervals of 12", with a minimum of 3 screws in each round metallic duct coupling.
- J. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections. Do not field-cut taps for branch connections in ducts with SMACNA pressure class magnitude more than 2 in wg.
- K. Install single-wall or double-wall round or flat-oval ducts in maximum practical lengths to minimize joints.
- L. Do not install any duct in an electrical equipment room unless that duct serves that room.
- M. Do not install any duct in an elevator equipment room unless that duct serves that room.
- N. Do not install any duct over an electrical transformer, electrical switchgear, or an electrical panel unless approved in writing by the Engineer.
- O. Maintain clearances required in the National Electric Code for electrically-powered items.
- P. Where ducts pass through interior partitions or exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal type and thickness as the duct. Overlap openings on all sides by at least 1-1/2 inches.
- Q. Where ducts pass through fire-rated partitions, install fire dampers unless otherwise indicated. Comply with requirements in other Division 23 Sections for fire dampers.

- R. Where ducts pass through smoke partitions, install smoke dampers unless otherwise indicated. Comply with requirements in other Division 23 Sections for smoke dampers.
- S. Install ductwork takeoffs at smoke dampers such that there is a minimum of 24" between the damper and the start of the first takeoff.
- T. Protect duct interiors from moisture, construction debris and dust, and other foreign materials by temporarily covering open ends of duct with clear plastic material until final connection is made. Comply with SMACNA "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts that are to be exposed in finished spaces from damage including dents, surface scratches, and markings. Exposed ducts must be undamaged and present a clean, neat appearance in materials and workmanship.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system in finished spaces.
- C. Grind welds to provide smooth surfaces free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets and inlets.
- E. Repair or replace ducts that do not comply with these requirements.
- F. Protect duct interiors from moisture, construction debris and dust, and other foreign materials by temporarily covering open ends of duct with clear plastic material until final connection is made. Comply with SMACNA "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.3 DUCT SEALING

- A. In accordance with ASHRAE 90.1, seal all ducts to SMACNA 006 seal class A with all transverse joints, longitudinal seams, and duct wall penetrations sealed. Seal openings for rotating shafts (including dampers) with bushings or other devices. However, do not seal an opening if sealing the opening would void a manufacturer's listing. Spiral lock seams in round or flat oval ducts do not require sealing unless leakage is detected.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA 006 Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA 006 Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports. Other types of hangers may be used if so indicated or if approved by Engineer.
- E. Vertical Ducts: Support vertical ducts with steel angles or channel secured to the sides of the ducts with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Upper Attachments: Install upper attachments secured to structural members. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials. Do not attach duct supports to roof decks.

3.5 CONNECTIONS

- A. Make connections to motorized equipment with flexible connectors complying with other Division 23 Sections. Comply with SMACNA 006 for branch, outlet, inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
 2. Test sections of metal duct system, chosen randomly by Engineer, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems." The cleanliness level is acceptable if the net weight of debris collected on the filter media does not exceed 0.75 mg/100 sq. cm. Perform test in at least 10% of the ducts in a given system, but perform no less than one test per system.
- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 DUCT CONSTRUCTION REQUIREMENTS

- A. Fabricate ducts with materials, pressure classes, and insulations indicated on Drawings.

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SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Manual volume dampers.
 2. Curtain-type fire dampers.
 3. Ceiling radiation dampers.
 4. Combination fire and smoke dampers.
 5. Flange connectors.
 6. Turning vanes.
 7. Duct-mounted access doors.
 8. Duct access panel assemblies.
 9. Flexible connectors.
 10. Duct accessory hardware.
 11. Exterior Vents.

1.2 SUBMITTALS

- A. Action Submittals:
1. Product Data: For each type of product.
 - a. For fire-dampers, smoke-dampers, combination fire- and smoke-dampers, and ceiling dampers include installation instructions.
 - b. For smoke-dampers and combination fire- and smoke-dampers include power, signal, and control wiring diagrams.
- B. Closeout Submittals:
1. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- C. Maintenance Material Submittals:
1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 2. Fusible Links: Furnish quantity equal to at least 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA 006 for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or Type 316 as indicated. Unless indicated otherwise, No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corp.
 - 4. McGill Airflow LLC.
 - 5. Nailor Industries Inc.
 - 6. Pottorff.
 - 7. Safe Air – Dowco Products.
 - 8. Vent Products Co., Inc.

- B. Round Manual Volume Damper: Diameter 20 inches or less, air velocity 1500 fpm or less, and duct static pressure class 2-inch or less. Galvanized steel sleeve with reinforcing beads. Single galvanized steel blade on axle with molded synthetic bearing at each end of axle and locking quadrant on standoff bracket. Basis of design Ruskin MDRS25.
- C. Round or Oval Manual Volume Damper: Diameter 48 inches or less, air velocity 4000 fpm or less, and duct static pressure class 10-inch or less. Galvanized steel construction for galvanized steel duct. Type 304 stainless steel construction for type 304 stainless steel or aluminum duct. Type 316 stainless steel construction for type 316 stainless steel duct. Rolled hat channel frame arranged for slip-in mounting. Single blade (or dual blades with center mullion for oval duct over 36 inches wide). Neoprene blade edge seals. Class II leakage rating. Blade mounted on axle with stainless steel sleeve bearing at each end of axle and locking quadrant on standoff bracket. Basis of design Ruskin CDR25 or CDO25.
- D. Rectangular Manual Volume Damper: Height 12 inches or less, air velocity 1500 fpm or less, and duct static pressure class 1-inch or less. Galvanized steel sleeve with blade stop. Single galvanized steel blade on axle with molded synthetic bearings and locking quadrant on standoff bracket. Basis of design Ruskin MD25.
- E. Rectangular Manual Volume Dampers: Height 5 inches or more, air velocity 1500 fpm or less., and duct static pressure class 3-inch or less. Galvanized steel hat channel frame with mitered and welded corners and blade stop. Flanged for attaching to wall and flangeless for installing in duct. Multiple single-thickness formed galvanized steel blades with opposed blade linkage enclosed in frame. Blades mounted on axles with molded synthetic bearings. Control shaft extended beyond frame with locking quadrant on standoff bracket. Basis of design Ruskin MD35.

2.4 CURTAIN-TYPE FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company DIBD series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Safe Air – Dowco Products.
 - 7. Vent Products Co., Inc.
- B. Type: Static or dynamic as indicated on Drawings; rated and labeled according to UL 555.
- C. Fire Damper Dynamic Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated on Drawings.

- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Frame and Blade Material: Galvanized steel (or stainless steel for aluminum or stainless steel duct).
- G. Frame: Frame roll-formed in gages required by UL listing; with mitered and interlocking corners. Blade lock.
- H. Blades: Roll-formed interlocking curtain blades operated by fusible link and stainless-steel closure spring. Link temperature rating 165 or 212 deg F as indicated on Drawings.
- I. Mounting Sleeve: Factory-installed, galvanized steel in length required for installation. Steel mounting angles. Ends of sleeve act as duct collars for Style A or B. Integral duct collars at ends of sleeve for Style C, CR, or CO.

2.5 CEILING RADIATION DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company CFD series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Safe Air – Dowco Products.
- B. General Requirements:
 - 1. Labeled according to UL 555C.
 - 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Heat-Responsive Device: Replaceable, 165 deg F or 212 deg F rated, fusible links.
- F. Fire Rating: 1, 2, or 3 hours as indicated.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company FSD60 series.

2. American Warming and Ventilating.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Safe Air – Dowco Products.

- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S.
- C. Damper Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated.
- E. Frame: Hat channel frame, minimum 16 gage, with mitered and interlocking corners.
- F. Blades: Single-piece airfoil blades equivalent to 14-gage strength, mounted on plated steel axles with permanently-lubricated stainless steel sleeve bearings pressed into frame. Parallel-blade-operation linkage concealed in frame.
- G. Seals: Flexible stainless steel compression jamb seals. Silicone blade edge seals mechanically fastened to blades; suitable for temperatures 450 deg F or less.
- H. Leakage: Class I.
- I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; thickness to meet UL requirements.
- J. Damper Motors: Modulating or two-position action as indicated.
- K. Smoke Detector: Integral, factory wired for single-point connection.
- L. Heat-Responsive Device: Resettable, 165 deg F or 212 deg F as indicated rated, fire-closure device and switch package, factory installed.
- M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in other Division 23 Sections.
- N. Accessories:
1. Auxiliary switches for position indication.
 2. Test and reset switches, damper or remote mounted as indicated.

2.7 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Ductmate Industries, Inc.
 2. Ward Industries; a brand of Hart & Cooley, Inc.

- B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. General Requirements: Comply with SMACNA 006.
- C. Vane Construction: Single wall for vanes up to 48 inches wide and double wall for larger dimensions.

2.9 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA 006. Double wall, rectangular door. Galvanized sheet steel with insulation fill and thickness as indicated for duct pressure class. Butt or piano hinges and cam locks, quantities as indicated in SMACNA 006. Doors airtight and suitable for duct pressure class. Galvanized sheet steel frame with bend-over tabs and foam gaskets. Vision panel where indicated.
- B. Pressure Relief Access Door: Door and frame of galvanized sheet steel. Double wall door with insulation fill and metal thickness applicable for duct pressure class. Open outward for positive-pressure duct and inward for negative-pressure duct. Factory set at 3.0-inch to 8.0-inch wg positive or negative. Door retaining device. Neoprene or foam rubber seal.

2.10 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ductmate Industries, Inc.
 - 2. Approved equal.
- B. Labeled according to UL 1978. Double-wall panel with two layers of steel, minimum 11 gage (0.12-inch thick) carbon or 11 gage (0.13-inch) stainless, steel type to match duct material. Carbon or stainless steel panel fasteners welded to inner wall and attached by threaded fasteners to outer wall. Fasteners shall not penetrate duct wall. Gasket

complying with NFPA 96; grease-tight and airtight, high-temperature ceramic fiber, rated for minimum 2000 deg F. Minimum pressure rating 10-inch wg, positive or negative.

2.11 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene. Minimum weight 26 oz./sq. yd. Minimum tensile strength 480 lbf/inch in the warp and 360 lbf/inch in the filling. Service temperature range minus 40 to plus 200 deg F.

2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 EXTERIOR VENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. X Vent Box.
 - 2. Approved equal.
- B. Description: Exhaust and intake ventilation termination products.
- C. Accessories:
 - 1. Provide integrated gravity back draft dampers for exhausts.
 - 2. Removable front louver.
 - 3. Paintable.
 - 4. Weather seal.
 - 5. Separator fin.
- D. Mounting: Adjustable mounting sleeve able to extend offset range from 1" to 9".
- E. Duct Connections: Single, double or triple duct connections. Refer to equipment schedule for quantity and size.

- F. Construction: UV stabilized, high impact polypropylene and ABS, designed to withstand high temperatures and harsh environments. Each fully-assembled unit is comprised of a seamless, monolithic box cavity with a removable front louver, positive pitch sidewalls and integrated removable recessed gravity dampers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories in accordance with manufacturers' instructions.
- B. Install duct accessories according to applicable details in SMACNA 006 for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Compliance with ASHRAE/IESNA 90.1 restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft or control damper (as indicated) at inlet of exhaust fan or in exhaust duct close to exhaust fan unless otherwise indicated.
- E. Install volume dampers only in ducts constructed to magnitude 2" pressure class or less. Provide at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- F. Set each damper fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install fire or smoke damper according to UL listing.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coil.
 - 2. Upstream and downstream from duct filter.
 - 3. At outdoor-air intake and mixed-air plenum.
 - 4. At drain pan.
 - 5. Downstream from manual volume damper, control damper, backdraft damper, and equipment.
 - 6. Adjacent to and close enough to fire or smoke damper to reset or reinstall fusible link. Door for access to fire or smoke damper having fusible link shall be pressure relief access door and shall be outward operation for access door installed upstream from damper and inward operation for access door installed downstream from damper.

7. Elsewhere as indicated.
- J. Install access door with swing against duct static pressure.
- K. Access Door Sizes:
 1. One-Hand or Two-Hand Access: 12 by 12 inches.
 2. Head and Hand Access: 18 by 12 inches.
 3. Head and Shoulders Access: 24 by 18 inches.
 4. Body Access: 30 by 18 inches.
 5. Body plus Ladder Access: 30 by 30 inches.
 6. Where duct width does not permit door size specified above, one dimension of door size may be reduced to 2 inches less than duct width.
- L. Label access door as specified in another Division 23 Section to indicate the purpose of the access door.
- M. Install flexible connectors to connect ducts to equipment. If vibrating equipment is internally isolated from casing, provide rigid duct connections.
- N. For fan developing static pressure of 5-inch wg or more, cover flexible connector with loaded vinyl sheet held in place with metal straps.
- O. Install duct test hole where required for testing and balancing purposes.
- P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during starting and stopping of fan.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Operate each damper to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed and that door can open fully.
 3. Operate fire, smoke, and combination fire and smoke damper to verify full range of movement and verify that proper heat-response or smoke-sensing device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operator to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

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SECTION 23 33 46

FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulated flexible ducts.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.
 - 2. Shop Drawings: For flexible ducts. Include plans showing locations and mounting and attachment details.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA 006 "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with Air Diffusion Council "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill Airflow LLC.

3. Thermaflex; a Flex-Tek Group.
 4. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-Value: R6.
- C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
- B. Non-Clamp Connectors: Liquid adhesive plus stainless steel tape.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts according to applicable details in SMACNA006 for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions or correct misalignments.
- D. Connect diffusers to ducts with flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with liquid adhesive plus stainless steel tape or draw bands.
- F. Installation:
1. Install ducts fully extended.
 2. Do not bend ducts across sharp corners.

3. Centerline radius of bends of flexible ducting shall not be less than one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns except as noted elsewhere.

G. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches on center.

END OF SECTION 23 33 46

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SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ceiling-mounted ventilators.
 - 2. Axial Fans.
 - 3. Centrifugal Utility Fans.
 - 4. Centrifugal Roof Ventilators.
 - 5. Propeller Sidewall Fans.

1.2 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevation.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - a. Certified fan performance curves with system operating conditions indicated.
 - b. Certified fan sound-power ratings.
 - c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - d. Material thickness and finishes, including color charts.
 - e. Dampers, including housings, linkages, and operators.
 - f. Roof curbs.
- B. Informational Submittals:
 - 1. Field quality-control reports.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.
- D. Maintenance Material Submittals:

1. Belts: One spare set for each belt-driven unit.

1.4 QUALITY ASSURANCE

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

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

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.
4. Twin City Fan & Blower.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheel directly mounted on motor shaft. Fan shroud, motor, and fan wheel removable for service.

D. Grille: High impact polystyrene grille with flange. Grille attached to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Motion Sensor: Motion detector with adjustable shutoff timer.
3. Isolation: Rubber-in-shear vibration isolators.
4. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.2 AXIAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.
 - 4. Twin City Fan & Blower.
- B. Housing: Constructed of rolled steel with a continuous seam weld, coated with an electrostatically applied and baked polyester urethane. Motor support framework to be constructed of structural steel welded to the fan casing and coated with an electrostatically applied polyester urethane.
- C. Fan Impeller: Cast aluminum airfoil blades adjustable within a cast aluminum hub to allow for performance changes, statically and dynamically balanced.
- D. Fan Motor and Drive: Motors shall be 3600 RPM, 60 Hz, totally enclosed fan cooled with a 1.15 service factor when operated across the line power or 1.0 service factor when used with a VFD. Motor shall be provided with a shaft grounding device to mitigate stray voltage peaks originating from use with a VFD.
- E. Sound Attenuator: All silencers shall be of 2 inch double walled construction with an outer wrap constructed of rolled steel and an inner wrap of perforated steel all coated with an electrostatically applied and baked polyester urethane. Attenuator length shall be two times the diameter of the fan housing. Provide inlet and outlet guards.

2.3 CENTRIFUGAL UTILITY FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Greenheck Fan Corporation
 - 2. Hartzell Fan Corporation
 - 3. Loren Cooke Company
 - 4. PennBarry
 - 5. Twin City Fan & Blower
- B. Housing: Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence. Fan shall be of airtight construction with the scroll panel material formed and embedded into the side panels. All interior and exterior surface untreated steel shall be coated with a high-performance powder coating. Housing and bearing support shall be constructed of bolted framework. An OSHA compliant belt guard shall be included to completely cover the motor pulley and belt(s).
- C. Fan Wheel: The fan wheel shall be of the single width backward inclined centrifugal type. Fan Wheel shall be statically and dynamically balanced to balance grade G6.3

per ANSI S2.19. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

- D. Fan Motor and Drive: Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 1770 in 60 Hz, Open Drip Proof (ODP). Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required. Movable motor plate with adjustment screws to make belt tensioning operations. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class. Bearings shall have Zerk fittings to allow for lubrication.
- E. Accessories: As indicated.

2.4 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Greenheck Fan Corporation
 - 2. Hartzell Fan Corporation
 - 3. Loren Cooke Company
 - 4. PennBarry
- B. Housing: The fan housing shall be constructed of spun aluminum with a removable weather tight motor covering, with an aluminum venturi inlet cone base, and provisions for positive motor cooling with fresh air.
- C. Fan Wheel and Motor: Centrifugal wheel both statically and dynamically balanced on vibration isolation mounts.
- D. Accessories: Variable speed controller, disconnect switch, bird screen, counterbalanced backdraft dampers and hinged subbase.
- E. Roof Curb: Galvanized steel, mitered and welded corners, 1.5-inch thick rigid fiberglass insulation adhered to the inside walls and 1.5-inch wood nailer.

2.5 PROPELLER FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.

1. Greenheck Fan Corporation.
 2. Hartzell Fan Corporation.
 3. Loren Cook Company.
 4. PennBarry.
 5. Twin City Fan & Blower.
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Aluminum Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- D. Direct Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Accessories:
1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings and blade seals.
 2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 3. Wall Sleeve: Galvanized steel to match fan and accessory size.
 4. Weather Shield Hood: Galvanized steel to match fan and accessory size.
 5. Weather Shield Front Guard: Galvanized steel with expanded metal screen.
 6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through metal conduit.

2.6 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors as indicated on Drawings and specified in another Division 23 Section. Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.7 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301. Factory test fans according to AMCA 300. Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210. Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans and accessories in accordance with manufacturer's instructions.

- B. Install power ventilators level and plumb.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Secure roof-mounted fans to structural steel base as indicated or roof curbs with cadmium-plated hardware. Coordinate roof curb installation with General Contractor.
- E. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- F. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 2 inches specified in another Division 23 Section.
- G. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension where applicable.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Provide and verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.

- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

END OF SECTION 23 34 23

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SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 SUBMITTALS

- A. Action Submittal:
 - 1. Product Data: For each product indicated, include the following:
 - a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - b. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 2. Color Samples for Initial Selection: For each product with factory-applied color finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Titus.
 - 2. Price.
 - 3. Krueger.
 - 4. Airmate.

2.2 DIFFUSERS, REGISTERS, AND GRILLES

- A. Architectural Ceiling Diffuser:
 - 1. Material: Steel **or Aluminum as indicated.**
 - 2. Finish: Baked enamel, white.
 - 3. Face Size: 24 by 24 inches.

4. Face Style: Plaque.
5. Mounting: Lay-In or Surface Mount, refer to schedule.
6. Accessories: Factory-insulated R-6 foil-backed insulation.
7. Ceiling Radiation Damper where indicated.

B. Linear Slot Ceiling Diffuser:

1. Material: Aluminum with steel pattern controller.
2. Finish: Baked enamel, white.
3. Mounting: Lay-in or surface mount, refer to schedule.
4. Slot Width: Refer to schedule.
5. Number of Slots: Refer to schedule.
6. Length: Refer to schedule.
7. Accessories: Factory fabricated plenum. Insulate around exterior of plenum.

C. Sidewall Supply Grille:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Mounting: Surface or Duct Mount.
4. Face Arrangement: Single or Double Deflection, refer to schedule.
5. Blades: Adjustable.
6. Blade Spacing: 3/4-inch.
7. Accessories: Opposed Blade Damper.

D. Eggcrate Grille and Register:

1. Material: Aluminum.
2. Finish: Baked enamel, white.
3. Face Arrangement: 1/2-by-1/2-by-1/2-inch.
4. Face Size: Refer to schedule.
5. Frame: 1-1/4 inches wide.
6. Mounting: Lay-In or Surface Mount, refer to schedule.
7. Damper (Register Only): Adjustable opposed-blade assembly.

E. Sidewall Return Grille:

1. Material: Steel
2. Finish: Baked enamel, white.
3. Mounting: Surface or Duct Mount.
4. Face Arrangement: 35° Fixed.
5. Blades: Fixed, blades parallel to long dimension.
6. Blade Spacing: 3/4-inch.

F. Ceiling Supply Grille:

1. Material: Steel
2. Finish: Baked enamel, white.
3. Mounting: Surface Mount.
4. Face Arrangement: Two-way throw.
5. Blades: 40° Fixed.
6. Blade Spacing: 1/2-inch.
7. Accessories: Integral multi-shutter damper with metal lever.
8. Ceiling Radiation Damper.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Provide sponge rubber gasket, mounting frame, and concealed fastener mounting on all surface mounted grilles and registers.
- E. Paint inside portion on all ductwork and plenums visible behind air device non-specular flat black enamel.
- F. Provide additional support for grilles, registers, and diffusers mounted in lay-in ceiling.
- G. Provide non-specular flat black steel blank-offs behind all unused portions of linear air devices.
- H. Coordinate exact location of Diffusers, Grilles and Registers with area smoke detectors, lights, and electrical devices. Air devices shall not be closer than 3 feet from area smoke detector.
- I. Final location of diffusers, registers and grilles shall be from architectural reflected ceiling plans.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 74 16.11

PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged, small-capacity, rooftop air-conditioning units (RTUs).

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each RTU.

- a. Include manufacturer's technical data.
- b. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.

2. Shop Drawings:

- a. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- b. Include diagrams for power, signal, and control wiring.

B. Informational Submittals:

1. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- a. Structural members to which RTUs will be attached.
- b. Roof openings.
- c. Roof curbs and flashing.

2. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in other Division 23 Sections.

- a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
- b. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

- c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 3. Field quality-control reports.
 4. Sample Warranty: For special warranty.
- C. Closeout Submittals:
 1. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
 2. Maintenance Material Submittals: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Fan Belts: One set for each belt-driven fan.
 - b. Filters: One set of filters for each unit in addition to filters installed during final cleaning.

1.3 QUALITY ASSURANCE

- A. AHRI Compliance:
 1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
 2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs with cooling capacities in excess of 65,000 Btu/h.
 3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. AMCA Compliance:
 1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
 2. Damper leakage tested according to AMCA 500-D.
 3. Operating Limits: Classify according to AMCA 99.
- C. ASHRAE Compliance:
 1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1.
 4. Comply with applicable requirements in ASHRAE/IES 90.1.
- D. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.4 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Carrier Corporation; a unit of United Technologies Corp.
 - 2. Daikin Applied.
 - 3. Trane.
 - 4. York; a Johnson Controls company.

2.2 CASING

- A. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Units surface shall be tested 1000 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit. Service panels shall have lifting handles and be removed and reinstalled by removing two fasteners while providing a water and air tight seal. All exposed vertical panels and top covers in the indoor air section shall be insulated with a cleanable foil faced, fire-retardant permanent, odorless glass fiber material. The base of the unit shall be insulated with 1/8", foil-faced, closed-cell insulation. All insulation edges shall be either captured or sealed. The units base pan shall have no penetrations within the perimeter of the curb other than the raised 1 1/8" inch high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting, with forklift capabilities on three sides of the unit.

2.3 UNIT TOP

- A. The top cover shall be one piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top.

2.4 COMPRESSORS

- A. All units shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors. Crankcase heaters shall be included on all units.

2.5 EVAPORATOR AND CONDENSER COILS

- A. Internally finned, 5/16" copper tubes mechanically bonded to a configured aluminum plate fin shall Microchannel condenser coils. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 575 psig. Plastic, dual-sloped, removable and reversible condensate drain pan with through-the-base condensate drain.

2.6 OUTDOOR FANS

- A. The outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motor shall be permanently lubricated and shall have built-in thermal overload protection.

2.7 INDOOR FAN

- A. Direct drive plenum fan design. Plenum fan design shall include a backward-curved fan wheel along with an external rotor direct drive variable speed indoor motor. All plenum fan designs will have a variable speed adjustment potentiometer located in the control box.
- B. Belt drive motors with an adjustable idler-arm assembly for quick adjustment to fan belts and motor sheaves. All motors shall be thermally protected. Variable speed direct drive motors. All indoor fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).

2.8 CONTROLS

- A. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device. Microprocessor controls provide for volt control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. A centralized Microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

2.9 REFRIGERANT CIRCUITS

- A. Each refrigerant circuit offer thermal expansion valve as standard. Service pressure ports, and refrigerant line filter driers are factory-installed as standard. An area shall be provided for replacement suction line driers.

2.10 PHASE MONITOR

- A. Phase monitor shall provide 100% protection for motors and compressors against problems caused by phase loss, phase imbalance, and phase reversal. Phase monitor is equipped with an LED that provides an ON or FAULT indicator. There are no field adjustments. The module will automatically reset from a fault condition.

2.11 GAS HEATING

- A. The heating section shall have a progressive tubular heat exchanger design using stainless steel burners and corrosion resistant steel throughout. An induced draft combustion blower shall be used to pull the combustion products through the firing tubes. The heater shall use a direct spark ignition (DSI) system. On initial call for heat, the combustion blower shall purge the heat exchanger for 20 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat/zone sensor. Units shall be suitable for use with natural gas or propane (field-installed kit). Provide single or two stage heaters as indicated.

2.12 ECONOMIZER

- A. This accessory shall be available with barometric relief. The assembly includes fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, spring return actuator and fixed dry bulb control. The barometric relief shall provide a pressure operated damper that shall be gravity closing and shall prohibit entrance of outside air during the equipment off cycle. The economizer arrives in the shipping position and shall be moved to the operating position by the installing contractor.

2.13 ROOF CURB

- A. The roof curb shall be designed to mate with the unit's horizontal supply and return and provide support and a water tight installation when installed properly. Curb design shall comply with NRCA requirements. Curb shall be shipped knocked down for field assembly and shall include wood nailer strips.

2.14 ZONE SENSOR

- A. This control shall be provided to interface with the Micro equipped units and shall be available in either manual, automatic programmable with night setback, with system malfunction lights, or remote sensor options.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install on roof structure, level and secure, according to AHRI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at unit.
 - 2. Connect ducts to RTUs with flexible duct connectors specified in Division 23.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- C. Where installing piping adjacent to RTUs, allow space for service and maintenance.
- D. Connect electrical wiring according to Division 26.
- E. Ground equipment according to Division 26.
- F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service in accordance with manufacturer's recommendations.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean interior of RTU and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 23 74 16.11

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SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: For power, signal, and control wiring.
4. Coordination Drawings: Plans, elevations and other details, drawn to scale, using input from installers of the items involved. Coordinate with all other construction including that which penetrates ceilings or is supported by them such as light fixtures, HVAC equipment, fire suppression equipment, fire alarm, etc.

B. Informational Submittals:

1. Field quality-control reports.
2. Operation and Maintenance Data: Operation and maintenance manuals.
3. Warranty: Sample of special warranty.

C. Closeout Submittals:

1. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
2. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Filters: One set for each air-handling unit.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Comply with the applicable requirements in:
 - 1. ASHRAE 15.
 - 2. ASHRAE 62.1.
 - 3. ASHRAE/IES 90.1.

1.4 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five years from date of Substantial Completion.
 - b. For Parts: One year from date of Substantial Completion.
 - c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers for use with Split System AHUs: Subject to compliance with requirements, provide products by the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Bryant.
 - 2. Lennox
 - 3. Trane.
 - 4. YORK; a Johnson Controls company.
- B. Manufacturers for use with Residential Apartment: Subject to compliance with requirements, provide products by the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Bryant.
 - 2. Lennox

3. Trane.
4. YORK; a Johnson Controls company.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. 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.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23.
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Filters: 1-inch thick, disposable, glass-fiber media, MERV-7.
9. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
 - b. Single-wall, stainless-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 55 deg F.
7. Hard start Kit with start capacitor and relay.
8. Mounting Base: Polyethylene.
9. Extreme condition mount kit to securely mount condensing unit in areas of high winds or on a rooftop.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23.
- B. Thermostat: Electronic programmable with subbase to control compressor and evaporator fan.
- C. Automatic-reset (anti-short cycle) timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction. Provide long line kits as required.
- E. Drain Hose: For condensate.
- F. 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 EXAMINATION

- A. Examine substrates, areas and conditions, with installer present, for compliance with the requirements for installation tolerances and other conditions affecting performance of the work.
- B. Examine rough-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floor and roofs for suitable conditions where split system air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23.
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Division 23. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 82 39.19

WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 SUBMITTALS

A. Action Submittals:

- 1. Product Data: For each type of product.
 - a. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- 2. Shop Drawings:
 - a. Include plans, elevations, sections, and details.
 - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - d. Wiring Diagrams: Power, signal, and control wiring.

B. Closeout Submittals:

- 1. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Berko; Marley Engineered Products.
 - 2. INDEECO.

3. Markel Products; TPI Corporation.
4. QMark; Marley Engineered Products.
5. Trane.

2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan (if required), motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. **Housing: Heavy gauge steel welded and phosphatized cabinet** with stamped-steel louver **and** removable panels fastened with tamperproof fasteners. **Convection heaters shall have aluminum extrusion enclosure with pencil-proof slots.**
- B. 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.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

- ~~A.~~ Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. **Convection heaters shall have aluminum fins bonded to sheath.** Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide **options as indicated.**

2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated. Comply with requirements in other Division 23 Sections.

2.6 CONTROLS

- A. Controls: Built in tamper-resistant thermostat.

- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Ground equipment according to Division 26.
- D. Connect wiring according to Division 26.

END OF SECTION 23 82 39.19

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SECTION 26 00 10
ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
1. Descriptions
 2. Quality Assurance
 3. Record and Information Manuals
 4. Examination of Site
 5. Warranty
 6. Definitions
 7. Load Balancing
 8. Scheduling
 9. Coordination Between Trades
 10. Coordination with Utility Companies
 11. Owner Furnished Equipment
 12. Materials and Equipment
 13. Approved Equals
 14. Manufacturer's Declaration
 15. Installation
 16. Painting and Related Work
 17. Cutting, Patching, and Openings
 18. Tests
 19. Temporary Power
 20. Cleaning
- B. This Section applies to all sections of Division 26, 27, and 28.
- C. All applicable requirements of other portions of the Contract Documents apply to the work of all sections of Division 26, 27, and 28, including, but not limited to, Division 01, General Requirements.

1.2 DESCRIPTIONS

- A. The Contractor shall provide the labor, tools, equipment, and materials necessary to complete and leave ready for operation all electrical systems as called for in these specifications or shown on the drawings and all details essential to complete the work. Items omitted from either the specifications or the drawings, but shown or described in the other trades, and all items necessary to make the electrical system complete and workable shall form a part of the work. No "extras" will be allowed.
- B. By submitting a bid, the Contractor certifies that:

1. He is satisfied that he understands all site conditions that may have an effect on his bid price.
 2. He fully understands the make-up, construction, and operation of all systems and equipment he is bidding on, and he has included in his price all materials, supplies, accessories, and services necessary to make these systems complete and operational.
- C. Extent of Work: Work under this contract consists of furnishing, installing, testing, placing into operation, and guaranteeing complete electrical systems as shown on the drawings and as specified in Division 26, 27, & 28. The Contractor shall connect and place all wired equipment in proper working order. Refer to the plans and specifications for work included in this Contract. Some general guidelines to coordinating work between Division 26 and other Divisions are as follows:
1. Division 26 includes all power wiring and raceways for other Divisions' equipment. Division 26 is responsible to furnish and install motor starters and disconnect switches for Division 21, 22 and Division 23 equipment, unless otherwise noted. Remote two wire control logic will be extended to the motor starters as work of other Divisions. Where combined line voltage power/control is used for Division 21, 22 or Division 23 equipment, the wiring and raceways are treated as power wiring and are work of Division 26.
 2. Division 26 is responsible for providing appropriate wire and conduit between all distribution equipment and all electrical devices and utilization equipment shown on plans. It is also the responsibility of Division 26 to provide all wire, conduit, and devices necessary to accomplish all control functions as indicated by the control diagrams which are not specifically shown as work of another division.
- D. Abbreviations used in these specifications:
1. ADA - Americans with Disabilities Act
 2. ANSI - American National Standards Institute
 3. ASTM - ASTM International
 4. CBM - Certified Ballast Manufacturers
 5. EIA- Electronic Industries Association
 6. ETL - Electrical Testing Laboratories
 7. FCC - Federal Communications Commission
 8. ICEA - Insulated Cable Engineers Association
 9. IEC - International Electro Technical Commission
 10. IES - Illuminating Engineering Society
 11. IEEE - Institute of Electrical and Electronics Engineers
 12. ITL - Independent Testing Laboratories
 13. NEC - National Electrical Code
 14. NECA - National Electrical Contractors Association
 15. NEMA - National Electrical Manufacturer's Association
 16. NESC - National Electrical Safety Code
 17. UL - Underwriters Laboratories
 18. A/E - Architect of Record or Engineer of Record

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. All work shall be installed in full accordance with the latest edition of the National Electrical Code (NEC) as prepared and published by the National Fire Protection Association (NFPA) and any applicable local or state codes. All electrical equipment shall be listed and labeled by Underwriters' Laboratories, Inc. (UL) or any approved independent nationally recognized electrical testing laboratory where such standards exist. Optionally, in lieu of such listing and labeling, equipment preapproved by the Electrical Inspector may be supplied. Wherever UL compliance is mentioned in the specifications, the above alternatives shall be understood to apply to all listing and labeling requirements. This does not preempt or replace the specifications or replace the approval process. All service switches/circuit breakers shall be listed and labeled as outlined above for service entrance duty.
 2. Comply with the requirements of NFPA Code 241 "Building Construction and Demolition Operations," the American National Standards Institute (ANSI) A10 Series standards for "Safety Requirements for Construction and Demolition," and the National Electrical Contractors Association (NECA) National Joint Guideline NJG-6 "Temporary Job Utilities and Services."
 3. In addition to the requirements outlined under other sections of the Contract Documents, all Work, material, and equipment shall comply with all requirements of the latest editions and interim amendments of the National Electrical Safety Code, National Fire Protection Association, OSHA, the building Owner's insurance company, and all applicable federal, state, and local laws and ordinances. All materials shall be listed and labeled by UL and installed as required by the listing.
 4. Should any changes in the Drawings or the Project Manual be required to conform to the above regulations, the Contractor shall notify the A/E at the time of submitting his bid. After entering into the Owner-Contractor Agreement, the Contractor shall be held to complete all Work necessary to meet these requirements without additional expense to the Owner.
- B. Permits and Regulations
1. The Contractor shall obtain all permits and inspections required by laws, ordinances, rules, regulations, and public authority having jurisdiction. The Contractor shall obtain certificates of such inspections and shall submit same to the A/E. The **Contractor** shall pay all fees, charges, and expenses in connection therewith. The Contractor shall furnish to the Owner a certificate of final inspection from the proper authority prior to final payment. Obtain and pay for easements required to bring temporary utilities to the site, where the Owner's easement cannot be utilized for that purpose.
 2. The Contractor shall not allow or cause any of the Work to be covered up or enclosed until the A/E or Owner has been notified and given reasonable opportunity (2 working days) to review the Work. When required by law or regulations, the governmental agency having jurisdiction for inspections shall be given reasonable notice and opportunity to inspect the Work. Any Work that is enclosed or covered up before such inspection and test shall be uncovered at the Contractor's expense; after it has been inspected, the Contractor shall restore the Work to its original condition at his own expense.

C. Interpretation of Drawings and Project Manual

1. Any discrepancies between Drawings, Project Manual, Drawings and Project Manual, or within Drawings and Project Manual shall be promptly brought to the attention of the A/E for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the A/E during the bidding period or of any error on the Contractor's part.
2. The locations of switch, receptacle, light, motor, outlets, etc. shown on Drawings are approximate. The Contractor shall use good judgment in placing the preceding to eliminate all interference with ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the A/E.
3. Check all door swings so that light switches are not located behind doors. Relocate switches as required, with A/E's review.
4. All general trades and mechanical Drawings shall be checked by the Contractor before installing any outlets, power wiring, etc.
5. Equipment sizes and locations shown on the Drawings are estimated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements, including wire and conduit entrance locations, and install wire, conduit, disconnect switches, motor starters, overload heaters, circuit breakers, or other items of the correct size and locations for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the A/E.
6. The Contractor shall provide all wiring, including disconnect switches and starters for all electrically operated equipment shown on Drawings, specified or required, except that starters and/or disconnect switches need not be furnished where it is specifically noted that they are furnished with the equipment.
7. The Drawings show the general arrangement required for installation of equipment and materials. The Contractor shall follow these Drawings as closely as possible. Should conditions necessitate other arrangements, the Contractor shall prepare and submit drawings showing the changes to the A/E for review before proceeding with the Work.
8. The A/E reserves the right to make minor changes in the location of the installation of equipment and materials up to the time of roughing in at no extra cost to the Owner.
9. The Drawings, do not show all offsets and do not detail every point at which unusual conditions of construction may require special attention. All additional fittings, conduits or specialties and other appurtenances necessary due to field conditions shall be provided by the Contractor.
10. In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such devices as are required to complete the installations.
11. Wherever in Division 26, 27, & 28 a Manufacturer is specified with the notation "or approved equal" or "A/E approved", the decision as to the material or equipment being "equal" shall be made by the A/E without exception and this decision shall be accepted by the Contractor as final. Where the Contractor proposes to furnish equipment or material in accordance with the "or approved equal" notation said equipment or materials shall be submitted to the A/E, for review.
12. Elevators: The location of switches, receptacles, lights, telephone outlets, etc., in elevator pits and shafts shall be located as required by the elevator Shop

Drawings. Elevator controls shall be interlocked with fire alarm system for elevator recall function and fire fighter control.

1.4 RECORD AND INFORMATION MANUALS

A. Record drawings

1. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - a. Raceway systems, size, contents, and location, for both exterior and interior; locations of all concealed utilities; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - d. Any deviations made necessary to incorporate equipment different from the Design Base equipment.
 - e. At completion of the project, contractor shall deliver record drawings to the A/E.
2. The Record drawings must be kept current and accurate, and may be reviewed at any time by the A/E or Owner.

B. Operations and Maintenance Manuals

1. Prepare maintenance manuals in accordance with Division 1 Section "Project Closeout." Compile and assemble the operation and maintenance data of equipment specified in Division 26 into a separate set of vinyl covered three ring binders, tabulated and indexed for easy reference. Data shall clearly indicate all options and accessories.
2. The following items, together with any other necessary pertinent data, shall be included in each Manual:
 - a. Each manual shall be labeled on front cover with project name, Contract, Contractor's name, A/E, and date of project completion.
 - b. Manufacturers' names, nearest Factory Representative, and model and serial numbers of components of systems
 - c. Operating instructions, start-up and shut-down procedures
 - d. Maintenance instructions.
 - e. Routine and 24-hour emergency service/repair information:
 - f. Name, address and telephone number of servicing agency
 - g. Names of personnel to be contacted for service arrangements
 - h. Parts list with numbers of replaceable items, including sources of supply
 - i. Manufacturers' literature describing each piece of equipment
 - j. One approved copy of each submittal
 - k. Written warranties
 - l. Certificate of Material Receipt and Certificate of System Completion
 - m. One typewritten directory for each panelboard as installed
 - n. Record (as-built) drawings
 - o. Certificate of Final Inspection signed by Building Authority having jurisdiction

- p. Test Results
 - q. Coordination analysis (see "Power System Coordination Analysis")
 - r. Video tapes of all equipment demonstrations and training sessions.
3. In addition to the requirements listed above and specified in Division 1, include the following information for equipment items:
- a. Manufacturers' Descriptive Literature
 - b. Final Signed Submittal Copy of Shop Drawings
 - c. Spare Parts and Replacement Parts Lists
 - d. Manufacturers' Maintenance and Service Manuals
 - e. Project-Specific Description of Operation
 - f. Wiring Diagrams
 - g. Motor list including motor description, motor horsepower, motor voltage, fuse size, fuse type, and overload size.
 - h. Fuse list including fuse location, fuse size, fuse type, and load description.
 - i. Fixture Ballast Schedule
 - j. Lamp Schedule
4. Materials for more than one item shall clearly indicate which item or items are included on the Project.
5. Shop Drawings which are folded and punched for insertion in the Manual shall be such that the Drawings can be unfolded without removing them from the Manual, and all information shall be legible.

1.5 WARRANTY

- A. Compile and assemble the warranties specified in Division 26 into a separate set of vinyl covered three ring binders, tabulated and indexed for easy reference.
- B. Provide complete warranty information for each item. Information to include:
 - 1. Product or equipment list.
 - 2. Date of beginning of warranty or bond.
 - 3. Duration of warranty or bond.
 - 4. Names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.6 DEFINITIONS

- A. Finished Areas: In general, areas with carpet or tile floors, lay-in or fixed ceiling tile, special architectural ceiling treatment, or tiled, plastered, or paneled walls shall be considered finished areas.
- B. Interior: For the purposes of this specification, interior is any area within the boundaries of the foundation of any building within the superstructure or other structures not classified as a building.
- C. Concealed: Embedded in or installed behind walls, within partitions, above suspended ceilings, below grade, in trenches, in tunnels and in crawl spaces.
- D. Exposed: Not installed underground or "concealed" as defined above

- E. Provide: To furnish and install (complete, tested, and ready for operation).
- F. Furnish: To purchase and deliver products to the project site and make ready for installation.
- G. Install: To take furnished products, assemble, erect, secure, connect, and place into operation.
- H. Products: Includes materials, systems and equipment.
- I. Work: The providing of products for entire contract.

1.7 SCHEDULING

- A. General: It is mandatory that the facility be maintained in operation during construction and that periods of shutdown due to line changeovers, etc. are held to a minimum. These outages must be scheduled with and have the concurrence of the A/E and Owner. Further, it is mandatory that the completion of various stages of the electrical work coincide with the other phases of construction to maintain and permit operation of new installations as construction progresses.

1.8 COORDINATION BETWEEN TRADES

- A. General
 - 1. Coordinate all requirements of the Work of this Division with other Trade Contractors. Such requirements include, but are not limited to, locations, sizes, anchors, and similar items.
 - 2. Provide all necessary information to other Trade Contractors for such coordination. Such information shall include conforming Shop Drawings, conforming Product Data, and all other required data.
 - 3. This Contractor shall bear all costs for providing affected Work of related Trade Contractor(s) with no change to the Contract Sum or Date of Substantial Completion.
 - 4. This Contractor shall coordinate all of his/her work with the General Trades Contractor for location of all devices, fixtures and equipment prior to rough-in.
- B. Mechanical/Electrical Coordination
 - 1. Plumbing, Fire Protection, HVAC, and Electrical Contractors shall coordinate their rough-in, service, and control requirements with each other. Electrical Contractor shall review all control drawings to coordinate exact number and locations of temperature control panels as well as to provide proper starters (including necessary time delays, auxiliary contacts, etc.).
 - 2. All wiring required to power Plumbing, Fire Protection, or HVAC equipment shall be installed by the Electrical Contractor, including 120 volt to temperature control panels. All control and interlock wiring, regardless of voltage, is by the Contractor furnishing the control panel. The Division 28 Contractor shall be responsible for the wiring from the fire alarm control panel to the control device.

3. All electrical devices furnished as a part of Division 23 equipment, and installation requirements of all electrical work done by Division 23 Contractors shall conform to the applicable sections of Division 26.
4. Electrical Contractor shall coordinate with other Contractors prior to installation of switchboards and panelboards to insure requirements of NEC Articles 110 and 408 are met. The Contractor violating this requirement shall be responsible for the cost of all modifications required to comply to the satisfaction of the inspection agency for failure to meet the above code requirements.
5. If motors and/or equipment are furnished by other Divisions, which require larger starters, safety switches, circuit breakers, fuses, and/or branch circuit conductors than indicated, due to a larger size than specified, the Contractor furnishing the motors shall reimburse the Electrical Contractor for any cost differential.
6. Final operation of equipment provided under other Divisions shall be the responsibility of the other Divisions Contractor.
7. Motorized dampers on exhaust fans shall operate when exhaust fan is energized. Wire dampers to their respective motor leads to energize the damper motor and open the damper when the fan runs. Equipment, including dampers, operator, and transformer (if required) will be furnished by the fan supplier. Motors fed from a variable frequency drive (VFD) shall be served from a separate branch circuit. Provide circuit to serve the dampers from the nearest panelboard (normal or emergency, to match motor). Control circuit through VFD damper control relay.

C. Foundations, Bases, Curbs, and Supports

1. Provide and coordinate all requirements for foundations, bases, curbs, and supports with the related Trade Contractor(s).
2. Provide required dimensions, templates, and all required information on anchors, sleeves, and cast-in-place accessories, including dimensions, to the related Trade Contractor(s).

D. Openings, Recesses, and Chases

1. Coordinate all requirements and locations for openings, recesses, and chases with the related Trade Contractor(s).

E. Final Connections

1. Coordinate with the related Trade Contractor(s) all requirements for rough-in and final connections for equipment installed under this Division.

1.9 COORDINATION WITH UTILITY COMPANIES

A. Description

1. The Division 26 contractor shall:
 - a. Coordinate division of responsibility with the utility companies serving the building.
 - b. Provide, furnish or install materials and labor not provided, furnished or installed by the utility companies.

B. Division of work-electric power utility

1. In general, the power company will do the following:
 - a. Provide standard riser with pole mounted transformers.
 - b. Provide primary cable

- c. Provide load break connectors
 - d. Provide Terminators
 - e. Provide grounding
 - f. Provide meter
 - g. Furnish meter trim
 - h. Furnish metering transformers
 - i. Provide meter wire from metering transformer to meter
 - j. Provide terminal pole and framing
 - k. Provide pad mounted secondary enclosure.
 - l. Provide line-side cables and terminations between secondary enclosure and transformer on pole.
 - m. Provide security padlock
2. The electrical contractor is responsible for all other work, including the following:
- a. Provide sleeve for grounding rod
 - b. Install meter trim
 - c. Provide conduit for meter wiring from CT Cabinet to meter trim
 - d. Provide guard post
 - e. Furnish easement or right-of-way
 - f. Provide concrete pad for secondary enclosure.
 - g. Provide trenching
 - h. Provide secondary duct from utility pole to secondary enclosure with pull string.
 - i. Provide service conductors from secondary enclosure to each service disconnect.
- C. Division of work-Telephone utility
- 1. In general, the telephone company is responsible for all service cable work, including furnishing and installing main service copper, fiber and coax cables to the building.
 - 2. The electrical contractor is responsible for all other work, including the following:
 - a. Providing trenching and backfill for telecommunications service conduits.
 - b. Furnishing and installing telecommunications service conduits.
 - c. Provide a minimum of a #6 solid copper ground wire from main building ground to telecommunication plywood backboard location. Provide the service entrance plywood backboard and a 120volt GFCI with TVSS double duplex receptacle.
- D. Division of work- – CATV and High Speed Data utility
- 1. In general, the Cable TV & High Speed Data internet utility company is responsible for all service cable work, including furnishing and installing main service, fiber and coax cables to the building.
 - 2. The electrical contractor is responsible for all other work, including the following:
 - a. Providing trenching and backfill for cable and internet communications service conduits.
 - b. Furnishing and installing cable and internet service conduits.
 - c. Provide a minimum of a #6 solid copper ground wire from main building ground to telecommunication plywood backboard location. Provide the service entrance plywood backboard and 120volt GFCI with TVSS double duplex receptacle.

1.10 OWNER FURNISHED EQUIPMENT

- A. The Contractor shall make all necessary provisions for the Owner furnished equipment.
- B. The Contractor shall remove, receive, store, uncrate, protect, and install the equipment in place, complete with field connections between shipping splits, feeder connections, and all appurtenances required to place the equipment in operation, ready for use. The Contractor shall be responsible for the equipment when received, as if he had purchased the equipment himself.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. New material and equipment; all bearing manufacturer's name, model number, or other identification marking.
- B. Provide standard product; latest design with published properties of manufacturer regularly engaged in production of specified material or equipment for minimum 5 years (unless exempted by A/E).
- C. Unless otherwise scheduled or indicated, equipment of same type in same room must match as to color, finish, and design.
- D. Unless otherwise submitted to and approved by A/E, equipment and its devices must be of same manufacturer; or devices must be approved and warranted by equipment manufacturer.
- E. Whenever the Contractor furnishes equipment or material other than the Design Base Manufacturer specified, the Contractor is responsible for the cost and coordination of all modifications required not only for his work, but also for the work of all other Trades affected. Where changes to other Trades' work are required, this Contractor must include the additional costs of all such work in his bid and ultimately make arrangements with these other Trades for such changes and compensate them accordingly. Where changes to design are required, the Contractor shall submit such changes to the A/E for approval. The Contractor shall investigate potential conflicts such as the following:
 - 1. Provide Physical dimensions and weights
 - 2. Code required working clearances
 - 3. Connecting pipe sizes
 - 4. Additional control and interlock wiring
 - 5. Lug size and quantity
 - 6. Increased wire size, fuse size, and motor control equipment size
 - 7. Increased ventilation requirements
 - 8. Battery capacity
 - 9. Sound levels of audible devices
 - 10. Increased withstand and interrupting ratings of downstream equipment due to differences in over-current protective device characteristics

2.2 APPROVED EQUALS

- A. Equal (equivalent) components (articles, devices, materials, forms of construction, fixtures, etc.) by manufacturers not listed but meeting the specifications may be submitted to the A/E for approval and subsequent inclusion into the bidding documents. Submission must be received no later than 10 working days before bid date. If approved, such manufacturers will be listed in an addendum.
- B. Submittals must include all of the following:
 - 1. Cover Letter: Company letterhead; addressed to A/E. Indicate the following
 - a. Project name, project number, and phase or bid package if applicable
 - b. Specification Section by number and title
 - c. Specified Product
 - d. Proposed Product
 - e. Deviations, if any, from Specified Product
 - f. List of attachments
 - 2. Product Data: Manufacturer's literature, fully describing proposed product with exact item highlighted or clearly indicated.
 - 3. Specifications: Manufacturer's specifications with all modifications noted as required to show compliance with Bidding Documents.
 - 4. Test Data: Where performance requirements are specified, submit laboratory tests to indicate compliance.
 - 5. Samples: Submit appropriate samples of proposed product when required by A/E, showing color, texture, construction and other attributes necessary for evaluation.

2.3 MANUFACTURER'S DECLARATION

- A. Submit a list of the suppliers of Major Equipment to be used on this project. This shall be submitted with the bid. This list shall be typed on company letterhead and shall list the project title. The manufacturer and catalog number/type shall be listed adjacent to each specification section number and product description.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Rough-In
 - 1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
 - 2. Refer to equipment specifications in other Divisions for rough-in requirements.
- B. Electrical Installations
 - 1. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - a. Coordinate electrical systems, equipment, and materials installation with other building components.
 - b. Verify all dimensions by field measurements.

- c. Coordinate and provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- d. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete or supported from or on other structural components, as they are constructed.
- e. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building and equipment which must be placed in service before further construction can take place.
- f. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- g. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service and place each in proper operating order.
- h. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that the work is shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the A/E before final placement.
- i. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- j. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- k. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PAINTING AND RELATED WORK

- A. Finish painting in areas of new construction is the responsibility of the General Trades Contractor and is specified in Division 9.
- B. Any other painting, required by Sections in Division 26, is the responsibility of the respective Division 26 Contractor. It shall meet the requirements of Division 9. Each Contractor is responsible for repainting of finished areas disturbed by his own cutting and patching.
- C. Factory-finished equipment which has rusted or has been damaged shall be cleaned, spot primed with zinc chromate, and finished to the original quality and color by the Contractor.
- D. Support steel shall be cleaned, rust removed, primed, and painted.

3.3 CUTTING, PATCHING AND OPENINGS

- A. Unless otherwise required in General or Special Conditions, Contractor shall perform all cutting and patching required for his own work. Work must be accomplished in a neat and workmanlike manner, acceptable to the A/E.
- B. If necessary to cut into work of other Trades, it shall be done by other Trades at this Contractor's expense. Patching shall be similarly executed.
- C. Cutting, burning or drilling of structural support beams, joists, plates, or other structural members is strictly prohibited without the specific written consent of the A/E. Use rotary drills where cutting holes through concrete, brick, plaster, or tile is necessary. Obtain approval of the A/E before proceeding with work.
- D. The General Trades Contractor shall locate and size openings for conduit, bus-way or other items prior to construction.
- E. All cutting and patching shall be done promptly and all repairs shall be made as necessary to leave the entire work in good condition, including all cutting, fitting, and drilling of masonry, concrete, metal, wood, plaster, and other materials as specified or required for proper assembly, fabrication, installation, and completion of all work of the Contract.
- F. Patching shall match adjacent materials and shall be accomplished only by trades men skilled in the respective craft required. Materials and equipment used in the patching work shall comply with requirements of those Sections of the Specification relating to material to be used in new construction.
- G. Electrical provides:
 - 1. All opening and hole information through floors, walls, and roofs for his work; Including all pipe and conduit, inserts, hangers, and plates.
 - 2. Exact information to other contractors as to size, depth, and location of such openings before construction is in place; and delivery and setting in place of all boxes, sleeves, inserts, and forms for his work in time for installation in all locations.
 - 3. All cutting, patching and restoration to accommodate Electrical contractor's failure to provide specified date in time for openings to be left or to accommodate boxes, sleeves, inserts, and forms after construction has been Completed by other contractors.
 - 4. Skilled craftsmen to cut, patch, rebuild, restore, replace, refinish and repaint new construction cut, disturbed, or marred by him to original or new condition; for installation of new, exposed, concealed, underground, or underfloor work of all kinds; for admission of new work and equipment; for installation of new equipment and new work in new construction; for complete restoration of pipe, duct, or equipment covering disturbed or marred by his personnel.

3.4 TESTS

- A. The Contract Documents, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction may require portions of the work to be inspected, tested, or approved. These services shall be performed by approved agencies.
- B. The A/E must be notified of all scheduled tests and adjustments at least 48 hours before they are scheduled so that he may witness same. If the Contractor performs any test or adjustment without the A/E present, or without proper notification, the Contractor may be required to perform the test or adjustment a second time. All schedules are to be coordinated with the A/E and Owner far enough in advance so-as to minimize inconvenience.
- C. Tests shall include:
 - 1. Proper operation of lights and equipment.
 - 2. Continuity of conduit system.
 - 3. Insulation leakage and impedances.
 - 4. Ground system resistance.
 - 5. Any sub-system tests described in other Sections of these Specifications.
 - 6. Record line voltage at service entrance equipment with all systems operating.
- D. Provide a signed statement that all tests have been performed and have met all requirements as described in other Sections. This signed statement shall be incorporated into the Record and Information Manual.
- E. The Contractor shall bear all costs of such inspections, tests, or approvals.

3.5 TEMPORARY POWER

- A. Provide temporary electrical power to be used for construction purposes by all contractors in accordance with Division 1. Provide all fixtures, wiring, and equipment, and make all connections required for temporary electrical service during the construction period; coordinate all power and lighting requirements with the various trades. Contractor to pay for energy consumption, and any utility company charges to establish service.
 - 1. Temporary Service Panels: Provide a minimum of one 100 ampere rated service panel in a location or locations within 200 feet of all building work areas; include as many such panels as required to meet 200 foot maximum distance. Provide all wiring and raceways required for service connection and branch circuit wiring connecting each panel to the serving utility and to the following electrical loads; obtain all permits required.
 - 2. Provide step-up transformer, 208/3 to 480/3, sized to accommodate tower crane to be used on project. Provide disconnect switch for tower crane.
 - 3. Lighting: Provide minimum of 5 foot-candles of illumination in all building work areas where construction work is being accomplished; increase illumination to 50 foot-candles for painting, plastering and other interior fine finish work.
 - 4. Outlets: Provide duplex receptacle outlets on 100 foot centers maximum; arrange and locate so that no work area of the building is more than 100 feet from a 120-volt outlet; allow no more than 5 outlets on any 20-ampere circuit.
 - 5. Power Circuit Breaker: Provide one 100-ampere, 208-volt, 3-phase or 240-volt, 1-phase circuit breaker in each panel for power equipment.

- B. Power shall be obtained from the local electrical utility.

3.6 CLEANING

- A. Upon completion of work, all materials and equipment furnished in this contract shall be thoroughly cleaned of dirt, grease, rust, and oil. Prepare for finish painting, where painting is specified.

END OF SECTION 26 00 10

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SECTION 26 00 15

SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes administrative and procedural requirements for submitting shop drawings, product data, color samples, and other miscellaneous submittals.
- B. This section applies to all sections of Division 26, 27 and 28.

1.2 DEFINITIONS

- A. Action Submittals: Written information that requires the Engineer's responsive action. Materials and equipment submitted shall meet all the requirements of the Contract Documents. No materials or equipment shall be ordered until the submittal has been reviewed and processed as "Reviewed for Compliance" or "Conform as Noted" by the Contractor, Architect, and Engineer.
- B. Informational Submittals: Written information that does not require the A/E's review. Information is submitted for record purposes only and will not be reviewed by the A/E. It is the Contractor's responsibility to make sure materials and equipment comply with the Contract Documents prior to ordering. If reviewed however, the submittals may be rejected for non-compliance with the requirements of the Contract Documents.
- C. Reviewed for Compliance: The submittal was reviewed for compliance by the Engineer and the submittal was found to generally conform with the design concept and Contract Documents.
- D. Conform as Noted: The submittal was reviewed for compliance by the Engineer and the submittal was found to generally conform with the design concept and Contract Documents with the exception of the items noted. The items noted by the Engineer must be changed and/or included, however, the submittal should not be resubmitted.
- E. Revise and Resubmit: The submittal was reviewed for compliance by the Engineer and the submittal did not conform with the design concept and Contract Documents. The items noted by the Engineer must be changed or included and the submittal must be resubmitted.
- F. Does Not Conform: The submittal was not reviewed because it is incomplete, inadequate for review, or does not meet the submittal requirements listed in the 'Quality Assurance' section below. The Contractor shall review the submittal requirements and resubmit.

1.3 QUALITY ASSURANCE

- A. The review of shop drawings by the A/E does not relieve the Contractor from his/her responsibility to comply with the project documents nor does it authorize any additional cost. The Contractor remains responsible for details and accuracy, for confirming and correlating all quantities, dimensions and weights, for selecting fabrication processes, for techniques of assembly, for performing his/her work in a safe manner and for all coordination of the work with all trades.
- B. Contractor assumes complete responsibility for changes required and contract delays, including that of other trades, as a result of his/her chosen materials and equipment.
- C. All submittals shall bear the Contractor's certification that he/she has reviewed, checked, and approved the submittal, that they have been coordinated with the requirements of the project and the provisions of the Contract Documents, and the he/she has verified all field measurements and construction criteria, materials, catalog numbers, and similar data. Submittals without a Contractor's approval will not be reviewed, will not be returned, and the Contractor will be notified.
- D. Submittals shall identify the manufacturer, specific model number, performance data, electrical characteristics, overall size, features, specified options, wiring diagrams, and any other information necessary to determine if the product or equipment conforms with the contract documents. Contractor shall submit only material applicable for the project, where catalog pages are submitted the contractor shall identify the specific items that apply. Additional equipment specific requirements may be listed in other spec sections.
- E. Submittals shall include the complete package of equipment materials, piping, and insulation pertaining to that piece of equipment. A package of equipment requiring long lead times should be submitted as early as possible.
- F. Where other specification sections require field quality control reports to be prepared by a Qualified Testing Agency, submit testing agency qualification as part of the Informational Submittals. Testing Agency shall be a member company of NETA or an NRTL.
- G. All submittals must be issued individually by specification section.
- H. Submittals which do not conform with the requirements above **WILL NOT BE REVIEWED**; they will be returned to the Contractor marked "Does Not Conform".

1.4 SHOP DRAWING SUBMITTAL PROCEDURES

- A. Electronic copies of the Contract Documents are available from the A/E for Contractor's use in preparing submittals.
- B. Contractor shall submit electronic copies of all shop drawings in PDF format. Electronic submittals shall be emailed to submittals@aecmep.com and the AEC Project Manager. Other means of file transmission such as FTP or other file format types shall be mutually agreed upon.

- C. Contractor shall prepare a title page for each submittal containing the following information:
 - 1. Indicate name of firm and individual with contact information for entity that prepared each submittal.
 - 2. Project name as listed on contract.
 - 3. Specification section number and title.
 - 4. Material or Equipment specified.
 - 5. Date.

PART 2 - PRODUCTS

2.1 SHOP DRAWING SUBMITTALS REQUIRED

- A. Submit information for all equipment described in the specifications and on the drawings.

2.2 INFORMATION SUBMITTALS

- A. Equipment specific information submittals are listed within equipment specification sections. General information submittal requirements are listed below. Information submittals shall be provided when indicated within equipment specifications sections.
 - 1. Qualification Data: For qualified testing agency
 - 2. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.
 - 3. Source quality-control reports.
 - 4. Field quality-control reports.

2.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Provide all information in bound 3-ring binder as well as digital format. Include the following information:
 - 1. All approved shop drawings.
 - 2. All information submittal information.
 - 3. Contractor's warranty and any specific equipment warranty provided by equipment manufacturers.
 - 4. Inspection certificates.
 - 5. Routine maintenance requirements and maintenance intervals for installed components as well as the name and address of qualified service agencies for all major equipment.
 - 6. Manufacturer's written instructions for testing and adjusting equipment.
 - 7. Spare parts list.
- B. Project close-out material: Provide as described in Division 01.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Notify the A/E in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents. The Contractor must boldly note all deviations on the submittal.
- B. Make submittals promptly in accordance with the approved schedule and in such sequence as to cause no delay in the work of the Contractor or any other Contractor.
- C. Correct or change and then resubmit rejected submittals as required until approved. The Contractor must clearly note all revisions on resubmitted submittals. Resubmittals without the revisions noted may be returned without review.
- D. Do not begin fabrication or work that requires an Action Submittal until submittal is processed as "Reviewed for Compliance" or "Conform as Noted" by the A/E.

END OF SECTION 26 00 15

SECTION 26 00 20

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Sleeves
 - 2. Seals
 - a. Watertight Seals
 - b. Fire Rated Seals
 - c. Corrosive Service Seals
 - 3. Firestops
 - 4. Concrete
 - 5. Access Panels
 - 6. Coordination Drawings

- B. This Section applies to all sections of Division 26 and 28.

1.2 SUBMITTAL

- A. Action Submittals:
 - 1. Manufacturer's product data sheets indicating product characteristics, performance and limiting criteria
 - 2. Manufacturer's installation instruction for each type of seal or firestop required by the project
 - 3. Written certification that firestopping systems meet firestopping requirements specified herein
 - 4. Concrete compression testing reports

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work associated with basic electrical materials in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein. Where provisions of the pertinent codes and standards conflict with this specification, the more stringent provision shall govern.
 - 1. American Institute of Steel Construction (AISC) "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings."
 - 2. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
 - 3. National Electrical Code (NEC).

1.4 COORDINATION

- A. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Field verify and coordinate with the General Trades Contractor all locations and dimensions to ensure that the equipment will be properly located, readily accessible, grouped with other trades equipment as needed, and installed in accordance with all pertinent codes and regulations, the contract documents, and the referenced standards.
- C. The work shall be carefully laid out in advance, and where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary for the proper installation, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.
- D. In the event any discrepancies are discovered, immediately notify the A/E in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Seals
 - a. Link-Seal by Thunderline Corporation
 - b. CSD Sealing Systems
 - c. O-Z/Gedney Inc.
 - d. Crouse Hinds
 - e. Appleton
 - 2. Firestopping Materials
 - a. Hilti
 - b. Tremco Sealants & Coatings
 - c. 3M Fire Protection Products
 - d. Dow Corning
 - e. CSD Sealing Systems
 - f. Insta-Foam Products, Inc.
 - g. The Carborundum Co.
 - 3. Access Panels
 - a. Milcor
 - b. Zurn
 - c. Larsen's
 - d. Acudor
 - e. JL
 - f. Nystrom
 - g. Karp

2.2 SLEEVES

- A. Sleeve material through floors and walls shall be machine cut rigid galvanized steel conduit.
- B. Sleeves installed in new construction shall have welded flange at mid-point of sleeve which functions as a water barrier and anchor collar.
- C. At the contractor's option, steel wall sleeves by Link-Seal may be provided.

2.3 SEALS

- A. Modular mechanical type
 - 1. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between conduit and sleeve.
 - 2. Seal assembly shall have steel bolts and nuts and rubber sealing element for service and environment under which assembly will be used. Seal shall have a pressure resistance rating of 20 psig.
- B. Sealing plug type
 - 1. Seals shall consist of two identical piece plugs made of synthetic rubber with one edge flanged, serrated profile on the outside and a series of ridges on the inside which compress and assures a tight seal. Seal shall have a pressure resistance of 15 psig at the plug base and 30 psig at the flange. Rubber grade shall be suitable for the service and environment under which sealing plug will be used.

2.4 WATERTIGHT SEALS

- A. Modular mechanical type watertight seals shall have zinc galvanized bolts and nuts with EPDM rubber sealing element. Seals shall be Link-Seal, Type C.
- B. Sealing plug type watertight seals shall be made of EPDM rubber. Seals shall be by CSD Sealing Systems.

2.5 FIRE RATED SEALS

- A. Modular mechanical type fire seal shall have zinc galvanized bolts and nuts with silicone rubber sealing element which provides a three hour fire resistance rating. Seals shall be Link-Seal, Pyro-Pac, model FS.
- B. Sealing plug type fire rated seals shall be made of FRR rubber for three hour fire resistance rating, Seals shall be by CSD Sealing Systems.

2.6 CORROSIVE SERVICE SEALS

- A. Modular mechanical type corrosive service seals have stainless steel bolts and nuts with rubber sealing element having high resistance to most organic compounds, acids, alkalis and related chemicals. Seals shall be Link-Seal, Type S.

- B. Sealing plug type corrosive service seals shall be made by Viton rubber. Seals shall be by CSD Sealing Systems.

2.7 FIRESTOPS

A. General

1. Use only firestop products that have been UL 1479, ASTM E-814 tested for specific fire rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
2. Cast-in-place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems), or electrical cable bundles, penetrating concrete floors.
3. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT).
4. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles and plastic pipe.
5. Foams, intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
6. Non-curing, re-penetrable intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
7. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes.
8. Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
9. Firestopping materials shall conform to both Flame (F) and Temperature (T) Ratings as tested by nationally accepted test agencies per ASTM E-814 or UL1479 Fire Tests of Through-Penetration Firestops.
 - a. The F rating shall be a minimum of one (1) hour, but not less than the fire resistance rating of the assembly being penetrated.
 - b. Conduct the fire test with a minimum positive pressure differential of 0.01 inches of water column.

2.8 CONCRETE

- A. All concrete work incidentals to the work of Divisions 26, 27, and 28 is the responsibility of the Division 26 contractor. Such concrete includes, but is not limited to:
 1. Encasement of underground raceways where specified in the section "Underground Ducts and Raceways"
 2. Lighting fixture foundations
 3. Service transformer pad
 4. Emergency generator concrete equipment base
 5. Housekeeping pads

2.9 ACCESS PANELS

- A. Furnish ceiling and wall access panels as necessary for access to pull boxes, junction boxes, remote ballasts, electrical equipment, etc., requiring service, adjustment or maintenance.
- B. Access panels are to be turned over to the General Trades Contractor for installation.
- C. Ceiling Access Panels
 - 1. Drywall Ceilings: 24" x 24", Milcor Style DW, 16 gauge steel frame with 14 gauge door panel, double acting concealed spring hinges, cylinder lock, prime painted for finish painting with ceiling.
 - 2. Fire-Rated Ceiling: 24" x 24", Milcor fire-rated access door, UL approved, 16 gauge steel frame with 18 gauge recessed door panel, 20 gauge panel sides and 26 gauge panel hat channel, continuous hinge, self-latching cylinder lock, prime painted for finish painting.
- D. Wall Access Panels
 - 1. Drywall: 24" x 24", Milcor Style DW, 16 gauge steel frame with 14-gauge door panel, double acting concealed spring hinges, cylinder lock, prime painted for finish painting with wall.
 - 2. Masonry and Tile: 24" x 24", Milcor Style M Standard, 14 gauge steel frame and door panel, concealed spring hinges, cylinder lock, prime painted for finish painting with wall or Style M stainless.
 - 3. Fire-Rated: 24" x 24", Milcor fire-rated access door, UL approved, 1-1/2 hour, Class B rating, 16 gauge steel frame, 20 gauge insulated door panel continuous hinge, automatic door closer, cylinder lock, interior release mechanism, prime painted for finish painting with wall.

2.10 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 - 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

- e. Show location and size of access doors required for access panels.
- f. Indicate required installation sequences.
- g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures, duct work, piping, and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. All penetrations through Fire-rated enclosures.
7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger. Include proposed elevation of conduits and raceways.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations. Include elevation of fixtures and devices.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines. Include mounting elevations.
8. Fire-Protection System: Show the following:

- a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 - b. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - c. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - d. All penetrations through Fire-rated enclosures.
9. Review: Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Engineer will so inform Contractor, who shall make changes as directed and resubmit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sleeves

1. Furnish and install sleeves for all penetrations through masonry and concrete construction, smoke or fire rated separations, and equipment room walls and floors.
2. Carefully coordinate and check locations of sleeves immediately before and after each concrete pour and masonry installation.
3. Give the General Trades Contractor locations and sizes of all openings required for the installation of sleeves before construction of masonry or concrete walls is started. If it becomes necessary to cut into new work because of the failure of this Contractor to notify the General Trades Contractor, then the General Trades Contractor shall do any necessary cutting and patching required at this Contractor's expense.
4. Cut sleeves through walls flush with each surface. Unused sleeves shall extend beyond wall surface, filled with and surrounded by fire barrier materials, and be provided with caps.
5. Cut sleeves 2 inches above finished floors and 3 inches above floors in equipment rooms and shafts. Bottom of sleeve to be cut flush.
6. Core drill holes for sleeves in existing construction.
7. Patching shall be by the General Trades Contractor at this Contractor's expense.
8. Sleeves must be installed plumb with respect to wall.
9. Pack the space between sleeves and conduits or cables with approved fire barrier sealant to maintain fire rating of structure. Fill space around all sleeves leading into exposed areas with material compatible with adjacent construction and finish or fire barrier sealant material to maintain fire rating of the structure.

B. Seals and Firestops

1. Clean surfaces and substrates of dirt, oil, loose materials and other foreign materials which may affect the proper bond or installation of seals and firestops.
2. Do not apply seals and firestops to surfaces previously painted or treated with a sealer curing compound or similar product. Remove coatings as required in

compliance with manufacturer's instructions. Provide primers, as required, which conform to manufacturer's recommendations for various substrates and conditions.

3. Follow manufacturer's written instructions for installation of seals and firestops.
4. Install firestops with sufficient pressure to fill seal holes, voids and openings to ensure an effective smoke seal and to maintain the fire resistance rating of the assembly.
5. Tool or trowel exposed surfaces. Remove excess firestop material promptly as work progresses and upon completion.
6. Unused sleeves shall be filled with and surrounded by firestop material. Sleeve ends shall be capped. Blind sealing plugs may be used at Contractor's option.
7. Install watertight seals for all below grade penetrations of conduit into the building.
8. Install fire rated seals in all fire rated walls and floors.
9. Install oil resistant service seals in environment where oils, fuels, solvents and other petroleum - base products are used.
10. Install corrosive service seals in environments where organic materials, acids, alkalis and related chemicals are used.

C. Concrete

1. Provide concrete compression testing for light pole foundations and exterior equipment pads.
2. Do not mount equipment on concrete supports until concrete has had sufficient setting time (seven days minimum).

D. Access Panels

1. Coordinate locations and installation of panels required to permit convenient access to electrical equipment requiring adjustment, service or maintenance. Mark locations of access panels on Record Drawings

3.2 FIELD QUALITY CONTROL

- A. Examine seals and firestops to ensure proper installation and full compliance with this specification. Work shall be accessible until inspection and approval by the applicable code authorities.
- B. Correct unacceptable seals and firestops and provide additional inspection to verify compliance with this specification at no additional cost to the owner.

END OF SECTION 26 00 20

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Okonite
7. Southwire Incorporated.

B. Aluminum and Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation:

1. Type THW-2
2. Type THHN-2-THWN-2
3. Type XHHW-2

D. Multiconductor Cable:

1. Type MC metal-sheathed cable, with ground wire. Refer to restrictions below.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.

2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

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

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Wire size shall meet or exceed the overcurrent device ampacity as required by NFPA 70. Where wire size shown on drawings is larger than the apparent ampacity requirements the size shown should prevail to account for voltage drop. The minimum conductor size shall be #12 AWG except for dwelling unit wiring, which may be #14 AWG.
- B. Service entrance conductors shall be copper.
- C. Aluminum conductors may be utilized for feeders within the building. Copper conductors shall be used for branch circuits smaller than No. 4 AWG.
- D. Solid conductors for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance may utilize the following:
1. Type THHN-2-THWN-2, single conductors in raceway
 2. Type XHHW-2, single conductors in raceway
- B. House Panel Feeders on all floors:
1. Type THHN-2-THWN-2, single conductors in raceway
 2. Type XHHW-2, single conductors in raceway

- C. Residence Unit Feeders, Where Concealed in Ceilings, Walls, Partitions:
 - 1. Below the podium level (non-combustible - metal frame construction)
 - a. Metal-clad cable, Type MC
 - 2. Above the podium level (combustible - wood frame construction)
 - a. Metal-clad cable, Type MC
 - b. Service Entrance Cable, Type SER
- D. House Power Branch Circuits Where Exposed:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
- E. House Power Branch Circuits Where Concealed in Ceilings, Walls, and Partitions:
 - 1. Metal-clad cable, Type MC
- F. Residence Branch Circuits Where Concealed in Ceilings, Walls, and Partitions:
 - 1. Below the podium level (non-combustible - metal frame construction)
 - a. Metal-clad cable, Type MC
 - 2. Above the podium level (combustible - wood frame construction)
 - a. Nonmetallic-sheathed cable, Type NM.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. MC Cable may be used for branch circuiting to wiring devices, where approved above, provided it is supported properly and run taut.
- B. MC Cable may be used for lighting fixture circuits where concealed above hard ceilings.
- C. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- D. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- H. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIELD QUALITY CONTROL

- A. Contractor shall perform insulation resistance (IR) tests, commonly called "megger" tests on any feeder or circuit which may have been damaged during installation or where identified as questionable by the Architect or Engineer. Test shall be performed according to standards published by ANSI/NETA.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.2 QUALITY ASSURANCE

- A. Comply with UL 467 for grounding and bonding materials and equipment.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Dossert; AFL Telecommunications LLC.
 - 3. ERICO International Corporation.
 - 4. Fushi Copperweld Inc.
 - 5. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - 6. Harger Lightning and Grounding.
 - 7. ILSCO.
 - 8. Newton Instrument Company.
 - 9. O-Z/Gedney; A Brand of the EGS Electrical Group.
 - 10. Robbins Lightning, Inc.
 - 11. Siemens Power Transmission & Distribution, Inc.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable unless otherwise required by applicable Code or authorities having jurisdiction. Conductors shall be identified by green insulation or by applying green tape at accessible locations.
- B. Bare Copper Conductors: Copper or tinned wire solid or stranded conductors.

- C. Grounding Bus: Predrilled rectangular bars of annealed copper, minimum 1/4" by 4 inches by 20 inches and, with 3/8-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

- A. UL Listed and acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, 3/4 inch by 10 feet. Provide sectional ground rods as needed.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Grounding Bus: Install in electrical equipment rooms, telecom rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Exothermic welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to all other Ground Rods: Exothermic welded connectors.
 - 4. Connections to Structural Steel: Exothermic welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Grounding electrode shall include, at a minimum, driven rod(s), metallic water piping system, concrete encased reinforcing steel, and structural steel. Install a main bonding jumper between the neutral and ground buses.
- B. Multiple services shall be interconnected with a dedicated 4/0 AWG bare copper grounding jumper installed in PVC raceway.

3.3 EQUIPMENT GROUNDING

- A. In addition to the complete metal conduit system, install insulated equipment grounding conductors with all feeders and branch circuits. Minimum equipment grounding conductor size shall be #12 AWG.
- B. Motor frames shall be bonded to the equipment grounding system by an independent ground wire, sized to match the equipment grounding conductor.
- C. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: On 208V systems without ground-fault protection at the main overcurrent device, install ground rod at the generator location. The ground rod shall be connected to the frame of the generator with #6 AWG copper supplemental grounding electrode.
- B. Pad-Mounted Transformers: Install grounding electrode. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to grounding electrodes. Bond the high voltage neutral, cable shields, conduits, and low voltage neutral.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 6 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least **three** rods (at each service) spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 70 feet apart.

3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements. Submit all ground bus to ground bus resistances by measurements back to main ground bus.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RGC: Rigid Galvanized Conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 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. Allied Tube & Conduit.
 - b. Eaton's B-Line Series – Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
2. Supports shall be hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Where installed outdoors or subject to corrosion stainless steel supports shall be provided.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, metallic raceways may be supported by openings through structure members, as permitted in NFPA 70.
- B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick. Powder-actuated fasteners may not be used in occupied buildings.
 - 6. To Steel: Welded threaded studs with lock washers and nuts, Beam clamps, or Spring-tension clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
 - 2. See additional requirements where painting specification are included as part of this project.
 - 3. Where finish painting is not included in the general trades contract, or when the Electrical Contractor is the sole contractor, provide prime coat and two finish coats of paint to all ferrous metal which is not galvanized.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780 / A780M.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. FMC: Flexible Metal conduit.
- C. RGC: Rigid galvanized threaded steel conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquid-Tight Flexible metal conduit.
- F. RNC: Rigid Nonmetallic Conduit.

PART 2 - PRODUCTS

2.1 CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.
 - 4. Carlon
 - 5. Cantex
 - 6. Champion
 - 7. Electri-Flex Company.
 - 8. O-Z/Gedney.
 - 9. Picoma Industries.

10. Republic Conduit.
11. Robroy Industries.
12. Southwire Company.
13. Thomas & Betts Corporation.
14. Western Tube and Conduit Corporation.
15. Wheatland Tube Company.

- B. Listing and Labeling: Conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CONDUIT TYPES - APPLICATIONS AND RESTRICTIONS:

- A. ARC: Comply with ANSI C80.5 and UL 6A.
1. For use where exposed in parking garage.
- B. RNC: Type PVC Schedule 40, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
1. For use underground, direct buried or encased in concrete.
 2. For use where exposed in parking garage.
- C. EMT Steel: Comply with ANSI C80.3 and UL 797.
1. Not to be used underground or where exposed to weather.
 2. Not to be used in utility tunnels, parking garage, or corrosive atmospheres.
- D. EMT Aluminum: Comply with ANSI C80.3 and UL 797A.
1. Not to be used underground or where exposed to weather.
 2. Not to be used in utility tunnels, parking garage, or corrosive atmospheres.
- E. FMC: Comply with UL 1; zinc-coated steel or aluminum.
1. For use with fixture whips and lighting fixtures (6' max).
 2. For connections to dynamic equipment and connections to motors in airstream.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
1. For connections to motors except where protection from physical damage is needed (in air stream).
 2. For use in wet locations or corrosive locations.

2.3 CONDUIT FITTINGS:

- A. Manufacturers: Subject to compliance with requirements, provide products equal to one of the following.
1. Appleton
 2. Cooper Industries
 3. Efcor
 4. Steel City
 5. T&B
 6. By Raceway Manufacturer
 7. or equal.

- B. Metallic fittings shall comply with NEMA FB 1 and UL 514b.
- C. All fittings shall be UL listed for the application.
- D. RGC
 1. Threaded fittings, malleable iron, with grounding bushing. Cooper Industries #800 series, or equal.
- E. RNC (PVC)
 1. Fittings shall be of the same material and manufacturer as the raceway, solvent welded type.
- F. EMT:
 1. Steel fittings, setscrew type, non-insulated, concrete tight. Cooper Industries #450 series, or equal.
- G. FMC:
 1. Non-insulated, malleable iron, clamp type. Cooper industries #700 series or equal
- H. LFMC:
 1. Steel or malleable iron. Cooper Industries Liquidator series, LTK series, or equal.
- I. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and include flexible external bonding jumper.
- J. Joint Compound for RGC, IMC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
- K. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 CONDUIT SIZES

- A. Minimum Raceway Size 3/4-inch trade size.

2.5 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 1. Cooper B-Line, Inc.
 2. Hoffman.
 3. Mono-Systems, Inc.

4. Schneider Electric - Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be NEMA 3R, listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: **Hinged type**, unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 1. Adalet.
 2. Allied
 3. Cantex
 4. Carlon
 5. Eaton
 6. EGS/Appleton Electric.
 7. Erickson Electrical Equipment Company.
 8. FSR Inc.
 9. Hoffman.
 10. Hubbell Incorporated.
 11. Kraloy.
 12. Milbank Manufacturing Co.
 13. Mono-Systems, Inc.
 14. O-Z/Gedney.
 15. RACO; Hubbell.
 16. Robroy Industries.
 17. Spring City Electrical Manufacturing Company.
 18. Stahlin Non-Metallic Enclosures.
 19. Thomas & Betts Corporation.
 20. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A. Boxes shall be galvanized or plated finish.

- D. Cast-Metal Outlet and Device Boxes: For use in surface mounted applications. Comply with NEMA FB 1, Type FD, with gasketed cover.
- E. Fiberglass Outlet and Device Boxes: UL listed for the application, with the appropriate fire rating, and where approved for use in paragraph 3 below.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square or octagonal by 2-1/8 inches deep. Provide extension rings as required for recessed boxes.
- J. Fire Rated Boxes: Provide fire rated device boxes, or fire rated box wrap, for all boxes installed in fire rated walls and ceilings.
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor application, Type 3R for outdoor applications (unless otherwise noted on drawings), with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type 1 for indoor application, Type 3R for outdoor applications (unless otherwise noted on drawings), 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.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. PVC Externally Coated, Rigid Steel Conduits: Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended

by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

- B. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F .
- C. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Complete raceway installation before starting conductor installation.
- A. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- B. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- C. Conduit shall be run overhead unless specifically shown on drawings to run under the slab.
- D. Conceal raceways within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- E. Support conduit within 12 inches of enclosures to which attached.
- F. Raceways Installed Below Slabs:
 - 1. Where feeders are permitted to run below slabs they should be installed in non-metallic conduit and encased in 3" envelope of concrete. Provide 6" layer of over fill above encasement.
 - 2. Conduits shall not be installed above the vapor barrier.
 - 3. Transition from RNC-PVC to RGC before rising above floor.
- G. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- H. 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.
- I. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to **1-1/4-inch** trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- N. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where an underground service raceway enters a building or structure.
 - 2. Where otherwise required by NFPA 70.
- R. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground conduit crossing building expansion joints. Maintain grounding continuity. Refer to architectural plans for locations or expansion joints.
- S. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **top** of box unless otherwise indicated.
- T. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

- V. Locate boxes so that cover or plate will not span different building finishes.
- W. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- X. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Y. Fiberglass boxes may be used within dwelling units only where appropriate fire ratings can be maintained

3.2 CONDUIT SUPPORT

- A. Secure feeder conduit to basic structural elements with galvanized strap hangers and clamps; use of trapeze type hangers is encouraged for multiple conduits where space will permit. Galvanized metal clamps and screws may be used for attaching and supporting branch circuit conduit. Nonmetallic fasteners shall not be used except plastic inserts may be used in concrete for small conduits.
- B. Vertical conduits shall be supported at each floor by clamps.

3.3 ANCHORS AND FASTENERS

- A. Anchors and fasteners shall be of a type designed and intended for use in the base material to which the material support is to be attached and shall be capable of supporting the intended load and withstanding any associated stresses and vibrations.
- B. In general, screws shall be used in wood, masonry anchors on concrete or brick, toggle bolts in hollow walls, and machine screws, bolts or welded studs on steel.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct-buried conduit, ducts, and duct accessories.
2. Concrete-encased conduit, ducts, and duct accessories.

1.2 RELATED DOCUMENTS

- ###### A. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for commonly used electrical conduit types, fittings, and adhesives.

1.3 DEFINITIONS

- ###### A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

PART 2 - PRODUCTS

2.1 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 EARTHWORK

- A. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- C. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.3 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of **48 inches**, both horizontally and vertically, at other locations unless otherwise indicated.

- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch .
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- H. Pulling Cord: Install 100-lbf- test nylon cord in empty ducts.
- I. Duct Construction:
 - 1. Excavate trench bottom to provide firm and uniform support for duct bank.
 - 2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 3. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts. Secure separators to earth and to ducts to prevent floating during fill. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 4. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 - 5. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of **60 inches** from edge of base. Install insulated grounding bushings on terminations at equipment.
- J. Concrete Encasement:

1. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 2. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 3 inches on each side of duct bank.
 3. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
 4. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 5. Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 6. Place minimum 6 inches of engineered fill above concrete encasement of duct bank.
- K. Direct-Buried Duct Banks:
1. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum 3 inches of sand as a bed for duct bank. Place sand to a minimum of 6 inches above top level of duct bank.
- L. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

- M. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches . Space additional tapes 12 inches apart, horizontally.

3.4 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Warning labels and signs.
 - 2. Equipment identification labels.

PART 2 - PRODUCTS

2.1 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR **36 INCHES**."

2.2 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Apply only to finished surfaces.
- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- C. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- B. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- C. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- D. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:
 - 1. Identify system voltage with black letters on an orange background.
 - 2. Apply to exterior of door, cover, or other access.
 - 3. For equipment with multiple power or control sources, identify all sources:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- F. Electrical Service Equipment: Electrical service equipment shall be provided with an equipment label identifying the available fault current at the equipment bus.
- G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual.
 - 1. Labeling Instructions:
 - a. Provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - c. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 26 05 53

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SECTION 26 05 81

MANHOLES, HANDHOLES AND UNDERGROUND PULL BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes manholes, handholes, and underground pull boxes.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work in compliance with ASTM, and applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
- B. Manufacturer Qualifications: Manufacturers of pre-cast manholes shall be firms regularly engaged in manufacturing factory fabricated manholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- C. Manholes shall be factory fabricated of reinforced concrete and in conformance with American National Standards Institute (ANSI) C 2, "National Electrical Safety Code (NESC)" and applicable requirements of American Society of Testing Materials (ASTM) C 478, "Specifications for Pre-cast, Reinforced Concrete Manhole Sections." Manhole structure shall be designed in accordance with requirements of the American Association of State Highway and Transportation Officials (AASHTO) publication "Standard Specifications for Highway Bridges." AASHTO H20 highway loading shall apply with 30 percent loading added for impact.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Precast Manholes and Handholes.
 - 1. Oldcastle Precast, Inc.
 - 2. Norwalk Concrete Industries
 - 3. Shea Concrete Products
 - 4. Smith-Midland Corp.
- B. Manhole and Handhole Frames and Covers
 - 1. East Jordan (EJ) Iron Works, Inc.
 - 2. Campbell Foundry Co.
 - 3. McKinley Iron Works

4. Neenah Foundry Co.

C. Cable Racks

1. Underground Devices Incorporated.
2. Hubbell Power Systems, Inc.
3. Or equivalent.

D. Pull Boxes.

1. Quazite by Hubbell
2. Syntertech by Oldcastle
3. MacLean Highline

2.2 MATERIALS

A. Pre-cast Manholes and handholes

1. Manhole dimensions shall be 6'x6'x8' minimum inside unless otherwise indicated on the drawings.
2. Handhole dimensions shall be 4'x4'x4' minimum unless otherwise indicated on the drawings.
3. Manhole and handholes shall be pre-cast unit consisting of two interlocking, mating sections, complete with accessory items, hardware, and features as indicated including concrete knockout panels for conduit entrance and sleeve for ground rod.
4. Joint sealant for joints between pre-cast sections shall be continuous extrusion of asphaltic butyl material compounded for the adhesion, cohesion, flexibility, and durability properties required for a permanent seal.

B. Manhole and Handholes Hardware and Accessories

1. Frames and covers shall be cast iron conforming to American National Standards Institute (ANSI) C2, "National Electrical Safety Code," Rule 323, AASHTO H-20 with 30% service factor. Furnish with cast in legend, "**High Voltage**", "**Electric**", or "**Telecom**" Cover to frame bearing surfaces machined.
2. Sump frame and grate shall comply with A-A-60005, Type VII (Sump Frame) for frame, Type I (Straight Traffic Frame) for cover. Locate sump at center of manhole directly below the cover.
3. Pulling eyes in walls shall be with rebar fastening insert. Working load embedded in 6 inch, 4,500 pounds per square inch (psi) concrete: 13,000 pounds minimum tension.
4. Bolting inserts for cable stanchions shall be flared, threaded inserts of noncorrosive, chemical resistant, nonconductive thermoplastic material. One-half inch internal diameter by 2 3/4 inches deep, flared to 1-1/4 inch minimum at base. Tested ultimate pull out strength: 12,000 pounds, minimum.
5. Expansion anchors for installation after concrete is cast shall be zinc plated carbon steel wedge type with stainless steel expander clip 1/2 inch bolt size, 5,300 pound rated pull out strength, and 6,800 pound rated shear strength, minimum.
6. Manhole cable support rack: heavy duty non-metallic rack, and support arms on each side wall.
7. Provide duct entry knockouts on each side.
8. Provide radius bell ends on all conduits in manholes.

9. Provisions for grounding. Provide exothermic T weld for 4/0 cable entering manhole from each duct bank. Conductors from each duct bank must be exothermic welded together for a continuous grounding path to the source. Provide 4/0 cable tap from the duct bank T weld to a 3" x 18" x 1/4" ground bar mounted on or near the ceiling of the manhole using standoff insulators. Attach all grounds entering the manhole to the ground bar using listed 2-hole compression lugs, antioxidant compound, bronze bolts and Bellville washers.
 10. Refer to manhole and handhole details for further requirements.
- C. Underground Pull Boxes
1. Underground pull boxes shall be factory fabricated of fiberglass reinforced polymer concrete. Boxes shall be stackable with minimum dimensions:
 1. **11" W x 18" L x 16" D**
 2. **17" W x 30" L x 16" D.**
 2. Covers: Provide heavy duty covers, Tier 15 rated for a service load of 15,000 pounds over a 10-inch square area. Covers shall read "High Voltage", "Electric", or "Telecom" as indicated. Covers shall be secured with stainless steel penta-head bolts.
 3. Openings: Openings shall be provided for duct number and size as indicated on plan.
- D. Ladder
1. Fiberglass manhole ladder, specifically designed for electrical manhole use. Minimum length equal to the distance from the deepest manhole floor to grade, + 3 feet. Supply one ladder at every manhole.
- E. Raceway/Duct Sealing Compound
1. Compound shall be nonhardening, putty like consistency workable at temperatures as low as 35⁰ F. Compound shall not slump at a temperature of 300⁰ F. and shall readily adhere to clean surfaces of plastic ducts, metallic conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals. Compound shall have no injurious effect on worker's hands and materials.
- F. Extra Materials
1. Furnish the following extra materials matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.
 2. Cable stanchions, support arms, insulators, and associated fasteners in the quantity of 10 percent of those installed for actual use in this project.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Provide manholes, handholes, and underground pull boxes of sizes, and shapes as indicated. Determine final grading of ducts as influenced by possible

adjustments in other utilities and surface features and discovery of underground obstructions before installing manholes, handholes, and underground pull boxes, **coordinate with Civil Engineer**. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

- B. Install manholes and handholes in approximate locations shown on plans in accordance with manufacturer's written instructions. Coordinate exact location with other utilities grading, paving and owner's representative.
- C. Duct Entrances to Manholes and Handholes: End bells spaced approximately 10 inches center to center for 5 inch ducts (5" typical or is 4") and varied proportionately for other duct sizes. The change from regular spacing to end bell spacing shall start 10 feet from the end bell and shall be made without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Slope ducts away from building, towards manhole.
- D. Drainage: Install drains in bottom of units where indicated. Arrange to coordinate with drainage provisions indicated or specified.
- E. Precast Access: Install access to manhole and handholes through cast iron frame and cover. Use 36" diameter cover except as indicated. Install precast concrete rings and seal with joint sealant as described in Part 2 of this specification. In addition, caulk all seams and joints inside and out. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.
- F. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted in, and prior to backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after brick mortar has cured at least 3 days.
- G. Field Installed Bolting Anchors: Do not drill deeper than 3 7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- H. Manholes provisions for future duct(s) to consist of formed opening(s) with structural steel placed around to permit easy knockout of opening in future.

3.2 INSTALLATION OF PRECAST MANHOLES, HANDHOLES, AND UNDERGROUND PULL BOXES

- A. Install in accordance with ASTM C 891, "Standard Practice for Installation of Underground Precast Concrete Utility Structures," and manufacturer's instructions.
- B. Support units on a minimum 12 inch deep level bed of #8 crushed stone.
- C. Compact backfill as required to set units securely in place. Backfill and grading shall be sloped to drain surface water away from access covers.

3.3 CLEANING AND RESTORATION

- A. Clean all internal surfaces including sump. Remove all foreign material.
- B. All manholes, handholes, and pull boxes shall be field inspected prior to acceptance by the Owner. Contractor shall be responsible for pumping manholes, handholes, and pull boxes to allow access for inspection.

END OF SECTION 26 05 81

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SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Photoelectric switches.
 - 2. Indoor occupancy sensors.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Intermatic, Inc.
 - 2. NSi Industries LLC; TORK Products.
 - 3. Leviton
 - 4. Sunrise Technologies
- B. Description: Solid state, with dry contact rated for 1800-VA, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 - 3. Time Delay: Fifteen second minimum, to prevent false operation.
 - 4. Surge Protection: Metal-oxide varistor.
 - 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.; Greengate
 - 2. Hubbell Building Automation, Inc.
 - 3. Leviton Manufacturing Co., Inc.

4. Lutron Electronics Co., Inc.
 5. Sensor Switch, Inc.
 6. Watt Stopper.
- B. Devices Types: Devices located in stairwells shall be ultrasonic type. All other locations shall be dual-technology (PIR and Ultrasonic) type, unless otherwise noted on drawings or in this specification.
- C. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast/driver load at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
- D. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating:
 - a. Line Voltage Units: Not less than 800-VA fluorescent or LED at 120 V, 1200-VA fluorescent or LED at 277 V.
 - b. Low Voltage Units: Suitable for use with relay-based lighting control system. Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack relay.
 4. Onboard 0-10V dimming control (sinking) with integral rocker switch for adjusting light levels up/down.

- E. General Requirements for Sensors: Extreme Temperature ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
 2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Operating Ambient Conditions: From **minus 40 to plus 125 deg F**.
 4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 5. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 6. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
 7. Bypass Switch: Override the "on" function in case of sensor failure.

2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **No. 22** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **No. 14** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within **twelve (12)** months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to **two (2)** visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.6 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
- B. **Train** Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

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SECTION 26 09 43

RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting control panels using mechanically held relays for switching.
2. Networked lighting control panels using control-voltage relays for switching.
3. Manual switches and plates.
4. Field-mounted signal sources
5. Cables and wiring

1.2 DEFINITIONS

- A. BAS: Building automation system.
- B. IP: Internet protocol.
- C. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- D. PC: Personal computer; sometimes plural as "PCs."

1.3 ACTION SUBMITTALS

A. Shop Drawings: For each relay panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Include diagrams for power, signal, and control wiring.
6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the network protocol.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.
- D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- E. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lighting Control Relays: Equal to ONE (1) percent of amount installed, but no fewer than TWO (2).

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with UL 916.

2.2 MANUFACTURERS

- A. Source Limitations: Obtain all components, sensors, wall switches, and control panels from single source from single manufacturer. Where specific manufacturer is named on the drawings, this manufacturer shall be the basis-of-design manufacturer.
- B. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Crestron
 - 2. Hubbell
 - 3. Legrand
 - 4. Leviton
 - 5. Lighting Control & Design (LC&D)
 - 6. Lutron
 - 7. nLight
 - 8. Pass & Seymour
 - 9. Steinel
 - 10. Watt Stopper

2.3 LIGHTING CONTROL RELAY PANELS

- A. Description: Relays may be standalone within a lighting control panel using mechanically latched relays to control lighting and appliances. Relays may also be distributed and located at the controlled fixtures. Control equipment may utilize a combination of both options.
- B. Lighting Control Panel:
 - 1. A single central enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
 - 2. A vertical barrier separating branch circuits from control wiring.

- C. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
 - 1. Timing Unit:
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Minimum of FOUR independent schedules, each having TWENTY FOUR time periods.
 - d. Schedule periods settable to the minute.
 - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - f. TEN special date periods.
 - 2. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blink warning" shall warn occupants approximately **FIVE** minutes before actuating the off sequence.
 - 3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.
- D. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire, 24-V ac.
- E. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.
- F. Operator Interface:
 - 1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
 - 2. Log and display relay on-time.
 - 3. Connect relays to one or more time and sequencing schemes.

2.4 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary contact, for operating one or more relays and to override automatic controls.
 - 1. Match color and style specified in Section 262726 "Wiring Devices."
 - 2. Integral green **LED neon** pilot light to indicate when circuit is on.
- B. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED SIGNAL SOURCES

- A. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.
- B. Indoor Occupancy Sensors **and Extreme-Temperature Occupancy Sensors**: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than **No. 24** AWG.
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than **No. 14** AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.

- B. Wiring Method: Install cables in raceways, cable trays, and/or cable management devices. Conceal raceway and cables except in unfinished spaces. All wiring shall be accessible.

- 1. Install plenum cable in environmental air spaces, including plenum ceilings.

- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 PANEL INSTALLATION

- A. Comply with NECA 1.
- B. Install panels and accessories according to NECA 407.
- C. Mount top of trim **72 inches** above finished floor unless otherwise indicated.
- D. Mount panel cabinet plumb and rigid without distortion of box.
- E. Install filler plates in unused spaces.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
- D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Acceptance Testing Preparation:

1. Test continuity of each circuit.

D. Lighting control panel will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform, Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for **two** years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **two** years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least **30** days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. **Train** Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 26 09 43

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Load centers.

1.2 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Comply with UL 67.

1.3 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **FIVE** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS/LOAD CENTERS

- A. All panelboards shall be rated, listed and labeled for the available short-circuit current by the manufacturer. Minimum interrupting rating of 10,000 amps.

- B. Panelboard Short-Circuit Current Rating: Fully Rated to interrupt symmetrical short-circuit current available at terminals.
- C. Load Centers: Series-Combination rating.
- D. Enclosures:
 - 1. Provide flush and surface enclosures as described on the drawings. Each enclosure shall be rated for environmental conditions at installed location.
 - 2. Provide NEMA 3R enclosures, at a minimum, where panelboards are installed outdoors.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 4. Finishes:
 - a. Panels and Trim: Steel with factory enamel finish.
 - b. Panel Tubs: Galvanized steel.
 - 5. Locking type doors with concealed hinges
 - 6. Panel tubs shall be 20" wide x 5" deep, minimum.
 - 7. Directory card mounted inside panelboard door inside a transparent card holder.
- E. Phase, Neutral, and Ground Buses:
 - 1. Material: Aluminum or Copper.
 - 2. Neutral bus (where required) shall be supplied separate from ground Bus.
- F. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: copper, or CU/AL bi-metallic type.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), NQ (240V) or NF (480V) Style or comparable product by one of the following:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
- B. Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.3 LOAD CENTERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), QO Style or comparable product by one of the following:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
- B. Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- C. Provide AFCI type circuit breakers for circuits serving dwelling units, dormitory units, and hotel/motel guest rooms and suites, in compliance with NEC 210.12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Wall mounted panelboards shall be installed so that the top of the cabinet is 6'-0" above the floor, coordinate panelboard location to avoid interference with other equipment.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box. Assure door swing does not interfere with other equipment.
- D. Install filler plates in unused spaces.
- E. Where panelboards are to be recessed, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

END OF SECTION 26 24 16

SECTION 26 27 13

ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes equipment for:
 - 1. Electricity metering by utility company
 - 2. Electricity metering non-utility.

1.2 DEFINITIONS

- A. PC: Personal computer.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Application and operating software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.4 QUALITY ASSURANCE

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

1.5 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 according to requirements indicated:
 - 1. Notify **Architect, Construction Manager, Owner** no fewer than **SEVEN** days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without **Architect's, Construction Manager's, Owner's** written permission.

1.6 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power services.
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- C. Meter Sockets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service **terminal box with lugs only, disconnect device**, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the drawings, this shall be considered the Basis-of-Design product.
 - a. Eaton
 - b. General Electric
 - c. Siemens
 - d. Schneider Electric (Square D)
 - 2. Comply with requirements of utility company for meter center.
 - 3. Housing: NEMA 250, **Type 3R** enclosure.
 - 4. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers.
 - 5. Main Disconnect Device: Fusible switch, series-combination rated by circuit-breaker manufacturer to protect downstream feeder and branch circuit breakers.
 - 6. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house load centers and panelboards that have 10,000-A interrupting capacity.

- a. Identification: Complying with requirements in Section 26 05 53 "Identification for Electrical Systems" with legend identifying tenant's address.
 - b. Physical Protection: Tamper resistant, with hasp for padlock.
7. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
 8. Surge Protection: For main disconnect device, comply with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits."

2.2 EQUIPMENT FOR ELECTRICITY METERING NON-UTILITY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D) or comparable product by one of the following:
 1. E-Mon; a division of Hunt Power.
 2. Eaton
 3. General Electric
 4. National Meter Industries.
 5. Osaki Meter Sales, Inc.
 6. Siemens

- B. Meter for Switchboard Use: Revenue grade meter suitable for flush mounted installation in door of NEMA 1 switchboard enclosure. Provide Schneider Electric # Power Logic PM8240 which includes the following features:
 1. Metered/Displayed Values: Voltage, Current, Frequency, Power factor (total and per phase), Apparent power (total, and per phase), Active and reactive power (total and per phase).
 2. Max/Min recording.
 3. Power Quality: Waveform Capture, Harmonic Distortion, Voltage Sag/Swell.
 4. Display Type: TFT LCD
 5. Accuracy: 0.2%, Class 0.2 by ANSI C12.20 and IEC 61557-12.
 6. Onboard Memory: 512 MB of time-stamped data recording.
 7. Web Services: Meter shall be capable of displaying data on web pages, alarm notification by email, and communication over ethernet, Modbus, TCP/IP

- C. Meter for Switchboard/Panelboard Use: Non-Revenue grade meter suitable for flush mounted installation in door of NEMA 1 switchboard/panelboard enclosure. Provide Schneider Electric # Power Logic PM5500 which includes the following features:
 1. Metered/Displayed Values: Voltage, Current, Frequency, Energy, Power factor, Active and reactive power.
 2. Max/Min recording.
 3. Display Type: Backlit LCD
 4. Accuracy: 0.5%, Class 0.5 by IEC 62053-22.
 5. Onboard Memory: 256 KB of time-stamped data recording.
 6. Communication: Meter shall be capable of communicating over ethernet, Modbus, TCP/IP.

- D. Meter for Panelboard Branch Circuit Use: Multi-circuit 120/277V single and double pole meter harnesses with remote wall mounted control and display cabinet. Provide Schneider Electric # Power Logic EM4900 which includes the following features:
 - 1. Metered/Displayed Values: Voltage, Current, Energy, Active and reactive power, Pulse Count.
 - 2. Display Type: Backlit LCD
 - 3. Accuracy: 0.5%
 - 4. Analog Input Type: Up to 24 Solid Core CT's.
 - 5. Communication: Meter shall be capable of communicating over ethernet, Modbus, BACnet, TCP/IP, HTTP.
- E. All electric meters shall comply with UL 1244.

2.3 SOFTWARE

- A. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation **and billing**.
 - 1. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs per tenant, building, or department. Coordinate requirements with Owner.
 - 2. Tenant or Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare **tenant bills, activity demand and energy-use statements** based on metering of energy use **and peak demand**. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.
- B. Technical Support: Beginning with Substantial Completion, provide software support for **TWO** years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within **TWO** years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide **30** days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

- C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Connect a load of known kilowatt rating, to a circuit supplied by metered feeder.
 - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 - 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 - 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 13

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI
 - 2. Weather-resistant receptacles.
 - 3. Snap switches and wall-box dimmers.
 - 4. Communications outlets.
 - 5. Device cover plates.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all wiring devices and associated wall plates from single source from single manufacturer.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper

- b. Hubbell
- c. Legrand
- d. Leviton
- e. Lutron
- f. Pass & Seymour

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices shall be side-wired. Devices that use modular plug-in connectors are not acceptable.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 volt, 20 amp: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Where installed within dwelling units, and where connected to 15A circuits, 15A receptacles may be utilized.
- B. All convenience and power receptacles located in common spaces shall be General Duty Specification grade, grounding type.
 - 1. Where installed within dwelling units, Residential Grade receptacles may be utilized.
- C. Weather resistant Receptacle shall be ultra-violet, corrosion, and impact resistant, with UL approved "WR" marking on face.
- D. Tamper Resistant Receptacles: All 120V and 250V, 15A and 20A, non-locking type receptacles installed in the following locations shall be listed Tamper Resistant, in compliance with NEC 406.12:
 - 1. Dwelling units
 - 2. Amenity spaces
 - 3. Corridors and Lobby

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed-through type, unless specified otherwise on Drawings.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, and FS W-C-596.

3. Comply with UL 943, device shall be self-testing and provide visual or audible alarm upon ground fault condition.
4. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

- B. Weather resistant Receptacle shall be ultra-violet, corrosion, and impact resistant, with UL approved "WR" marking on face.

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Within dwelling units light switches shall be decora style with matching coverplates.
- C. Switches, 120/277 volt, 20 amp.
- D. Pilot-Light Switches, 20 amp:
1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- E. Key-Operated Switches, 120/277 volt, 20 amp:
1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 volt, 20 amp; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.6 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable Slider, with single-pole or three-way switching. Comply with UL 1472.
- C. Led Lamp Dimmer Switches; 0-10V compatible with dimmer driver.

2.7 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces:
 - a. High impact smooth nylon in **White** finish.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: White
 - 2. Wiring Devices Connected to Emergency Power System: RED.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including final painting, is complete.
- C. Conductors:
 - 1. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 2. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 3. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Do not remove surface protection, such as plastic film and smudge covers, until immediately prior to occupancy.
3. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
4. Tighten unused terminal screws on the device.
5. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Devices shall be installed vertically with ground pin up, where explicitly shown to be mounted horizontally, position the ground pin to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. The use of caulk around device plates to seal gaps shall not be permitted.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Adjust mounting height and location of Devices: Where devices are installed to serve furniture or furnishings, or otherwise located in the vicinity of furniture or furnishings, the mounting height and location of such Devices shall be adjusted to permit full access to the Devices without the need to move furniture or furnishings. Provide proposed modifications of mounting height and locations for each Device to be changed to Engineer for approval prior to rough-in of said Device.

3.2 WEATHER RESISTANT RECEPTACLES

- A. All 125 volt, 15 amp and 20 amp receptacles installed in damp or wet locations shall be UL listed as weather-resistant and have "WR" mark on face of receptacle. Receptacles installed outside shall be provided with a weather-proof "in-use" cover.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 27 26

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SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in the following:
 - a. Enclosed switches and controllers.
 - b. Site pole lighting bases.

PART 2 - PRODUCTS

2.1 FUSES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper Bussman or comparable product by one of the following:

1. Cartridge Fuses
 - a. Mersen
 - b. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: Fuses shall be current-limiting with 200,000 Amps interrupting rating and carry a UL label.

1. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting; 600V – LP-CC
2. Type RK1: Thru 600A, 200 kAIC, dual element, time delay; 250V – LPN-RK, 600V – LPS-RK.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Within each fusible device, install fuses that are of the same class and rating. Do not mix class or amperage ratings between multiple fuse positions.

3.2 IDENTIFICATION

- A. Install labels complying with requirements for identification specified elsewhere and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Disconnect switches.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Eaton
 2. General Electric
 3. Siemens
 4. Schneider Electric (Square D).
- B. Type HD, heavy duty, fusible and non-fusible, disconnect switches. Switches shall be horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Standard Duty, fusible disconnect switches where serving roof mounted residential condensing units.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Corrosive Environments: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Install fuses in fusible devices.
- C. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION 26 28 16

SECTION 26 28 17

ELEVATOR SAFETY SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide the labor, tools, equipment, and material necessary to install safety switches in accordance with the plans and as specified herein.

1.2 QUALITY ASSURANCE

- A. All work shall be performed in accordance with the latest edition of applicable standards, codes and laws.
 - 1. NFPA 70 – Current Edition; Article 620.
 - 2. ANSI/ASME A17.1 – Current Edition.
 - 3. BOCA 3006.2.3
 - 4. NFPA 72 – Current Edition.
- B. Except as modified by governing codes, all equipment shall be manufactured in accordance with the latest applicable standard
 - 1. U.L. 98 and CSA – C22.2 No. 4

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Elevator Control Switch in a single NEMA 1 enclosure with all necessary relay(s), control transformer and other options (as listed below), and as shown on drawings. The Elevator Control Switch shall be constructed, listed, and certified to the standards as listed in above. The Elevator Control Switch shall include the following features:
 - 1. Horsepower rated fusible switch with shunt trip capabilities. The ampere rating of the switch shall be based upon elevator manufacturer requirements and use Class J Fuses.
 - 2. Include as an accessory, a 100 VA control power transformer with primary and secondary fuses. The primary voltage rating shall match the incoming circuit voltage with a 120-volt secondary.
 - 3. Contain isolation relay (3PDT, 10 amp, 120V). The coil of the isolation relay shall be 120 Vac. A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid.
 - 4. Include a 120-volt key to test switch.
 - 5. Provide mechanically interlocked auxiliary contacts (1 N.O./1 N.C). rated 5A, 120 Vac as standard.

6. The switch shall contain the following options:
 - a. "ON" Pilot Light (Green)
 - b. Isolated Full Capacity Neutral Lug
 - c. Fire Alarm Voltage Monitoring Relay

B. Refer to Section "Fuses" for additional fuse requirements.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the drawings, this shall be considered the Basis-of-Design product.
 1. Cooper Bussmann
 2. Eaton Corp.
 3. Littelfuse
 4. Mersen

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install safety switches as indicated, complying with manufacturer's written instructions.
- B. Install safety switches for use with elevator equipment, motors and controllers within sight of the motor position unless otherwise indicated.
- C. Provide suitable means for mounting safety switches.
- D. Use flexible conduit to and from safety switches where vibration isolation is required.
- E. Provide fuses sized in accordance with equipment manufacturer's data plate.
- F. Fuses shall not be installed until equipment is ready to be energized
- G. Touch-up all scratches after installation.

END OF SECTION 26 28 17

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual motor starters
 - 2. Full-voltage magnetic motor starters

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), or comparable product by one of the following:
 - 1. Eaton
 - 2. General Electric
 - 3. Rockwell Automation
 - 4. Siemens

2.2 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

- B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Configuration: Nonreversing.
 - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 - 3. Flush devices where installed in finished spaces, otherwise surface mounting.
 - 4. Red pilot light.
- C. Magnetic Controllers: Full voltage, across the line, electrically held.
 - 1. Configuration: Nonreversing.
 - 2. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 4. Control Circuits: **120V** ac.
 - 5. Integral CPT, with primary and secondary fuses, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 6. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - 7. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
 - 8. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate **Class R** fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 9. Nonfusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

10. Auxiliary Devices: Provide heavy duty pushbuttons, LED pilot lights to indicate motor status, and Hand-Off-Auto (HOA) rotary switch. All devices shall be factory mounted in enclosure cover.

2.3 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 1. Provide NEMA 1 enclosures for indoor dry environments. Where located outdoors, or in wet environments provide NEMA 3R enclosures, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.2 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.
- B. Connect selector switches and other automatic-control selection devices where applicable.
 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

END OF SECTION 26 29 13

SECTION 26 41 13
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 ALTERNATE BID

- A. Lightning protection for this building shall be considered an alternate bid item. Refer to the description of alternates in Div. 01 for more information.

1.2 SUMMARY

- A. Section includes lightning protection system for the following:
 - 1. Ordinary structures.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, coordinated with each other, using input from installers of the items involved:
- B. Qualification Data: For Installer.
- C. Product certificates.
- D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Completion Certificate:
 - 1. UL Master Label Certificate

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Dossert; AFL Telecommunications LLC.
 - 3. ERICO International Corporation.
 - 4. Fushi Copperweld Inc.
 - 5. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - 6. Harger Lightning and Grounding.
 - 7. ILSCO.
 - 8. Newton Instrument Company.
 - 9. O-Z/Gedney; A Brand of the EGS Electrical Group.
 - 10. Robbins Lightning, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. UL Lightning Protection Standard: Comply with UL 96A requirements for **Class II** buildings.
- B. 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** unless otherwise indicated.
 - 2. Minimum 1/2-inch diameter by 12-inch long.
 - 3. Rounded safety tip.
 - 4. Threaded base support.
- B. Main Conductors:
 - 1. **Stranded Copper**
- C. Secondary Conductors:
 - 1. **Stranded Copper**
- D. Ground Loop Conductor: Stranded copper.
- E. Ground Rods:
 - 1. Material: Copper-clad steel.

2. Diameter: 3/4-inch.
3. Rods shall be not less than 120-inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A.
- 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.
- 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 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.
- 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 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 26 41 13

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SECTION 26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes field-mounted Surge Protective Devices (SPDs) for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Refer to the following specification sections for Surge Protective Devices which are to be factory installed in equipment.
 - 1. 26 24 16 – Panelboards

1.2 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.3 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **Five** years from date of Substantial Completion, unless listed otherwise in the following paragraphs.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Where surge protective device is shown attached to an automatic transfer switch or other equipment without integral overcurrent protective devices, provide surge protective device with integral disconnect switch.
- D. Provide device in powder coated, impact resistant steel enclosure. Where shown to be installed outdoors, provide weatherproof NEMA 3R enclosure.

2.2 SPD FOR SERVICE EQUIPMENT.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (JSP-240) or comparable product by one of the following:
 - 1. Eaton
 - 2. Emerson
 - 3. GE
 - 4. Schneider Electric
 - 5. Siemens
- B. Provide UL 1449, Type I devices suitable for the voltage shown on the drawings.
- C. Surge capacity of 240,000A per phase, 120,000A per mode, fully rated (SCCR) of 200KAIC, with TEN modes of protection (L-L, L-G, L-N, N-G). Each mode shall be protected with individually fused MOVs. Nominal discharge current (I-n) shall be 20,000A.
 - 1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Surge counter.
 - c. Transient Filter complying with UL 1283 for electromagnetic interference.
 - d. Form-C contacts (1 N.O, 1 N.C.), for remote monitoring of protection status.

2.3 SPD FOR ELEVATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (TransEnd 50) or comparable product by one of the following:
 - 1. Eaton
 - 2. Emerson
 - 3. GE

4. Schneider Electric
5. Siemens

B. Provide UL 1449 Type II devices suitable for the voltage shown on the drawings.

C. Surge capacity of 100,000A per phase, 50,000A per mode, fully rated (SCCR) of 65KAIC, with TEN modes of protection (L-L, L-G, L-N, N-G). Each mode shall be protected with individually fused MOVs. Nominal discharge current (I-n) shall be 20,000A.

1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Metallic flexible conduit whip.
 - c. Transient Filter complying with UL 1283 for electromagnetic interference.
 - d. Form-C contacts (1 N.O, 1 N.C.), for remote monitoring of protection status, where indicated on drawings.

2.4 SPD FOR SINGLE-PHASE LOADS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (Surgitron III) or comparable product by one of the following:

1. Eaton
2. Emerson
3. GE
4. Schneider Electric
5. Siemens

B. Provide UL 1449, Type 2 devices suitable for the voltage shown on the drawings.

C. Surge capacity of 40,000A per phase, fully rated (SCCR) of 50 KAIC, with all modes of protection. Each mode shall be protected with individually fused MOVs.

1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Metallic flexible conduit whip.
 - c. Three year warranty.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No.22 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.

END OF SECTION 26 43 13

SECTION 26 51 19

LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for LED luminaires indicated in the Luminaire Schedule on the drawings.
- B. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

- b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - 7. LED driver or power supply product data sheets for each luminaire.
- B. Shop Drawings: For nonstandard or custom luminaires.
- 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Where specifically indicated on plans, include photometric PxP drawings for areas where alternate fixtures are supplied.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of luminaire.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
- 1. One (1) copy of each approved submittal.
 - 2. Certificate of Material Receipt.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Drivers: TEN percent of each type and rating installed. Furnish at least one of each type.

2. Diffusers and Lenses: ONE percent of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: ONE percent of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: FIVE year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide Luminaires as scheduled on the Drawings.
- B. Provide luminaires with integral thermal protection.
- C. LED luminaire shall be modular in design with the ability to replace individual components (LED Modules, drivers, etc.) without having to replace the entire luminaire.
- D. All LED luminaire shall have a minimum CRI of 80.
- E. LED/LED Module and driver shall be rated for a minimum of 50,000 hours of life at 80% output (LM-80).
- F. For each type Luminaire, the LED/LED Module shall originate from a common manufactured batch source.
- G. All LED/LED Module shall adhere to LED package manufacturer guidelines, certification programs, and test procedures for thermal management.
- H. Driver shall be FCC Part 15 compliant, UL 8750.
- I. Driver shall meet ANSI C62.41 category A surge protection standards up to 4kV.
- J. All LED drivers shall have a power factor greater than 0.90.

- K. Emergency LED battery pack shall be integral mounted, ninety (90) minute capacity, sealed maintenance free nickel cadmium battery and integral charger, operate at rated lumen output of fixture or next highest lumen output available providing no less than 50% of the standard lumen output, and have remote mountable charging indicator light and test switch. LED drivers shall feature a self-diagnostic circuit that automatically tests unit and reports failure with an audible and visual alarm.
- L. Ambient Temperature: Indoor Luminaires, 41 to 104 deg F.; Outdoor Luminaires, 5 to 104 deg F.
 - 1. Relative Humidity: Zero to 95 percent.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- F. California Title 24 compliant.

2.3 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch minimum diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 14 AWG. Min.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaires:

1. Where recommended by luminaire manufacturer, attach to structural members in walls. Otherwise mount fixture to back box.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Ceiling Mount:
 - a. Provide quantity of stems or adjustable aircraft cable to support suspended fixtures as described in the luminaire schedule and manufactures installation instructions.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use stems, rod, or aircraft cable support as indicated in luminaire schedule, for suspension of each unit length of luminaire chassis, including one at each end. Maximum span shall not exceed 12'.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Do not use ceiling grid alone to support for luminaires. Support with aircraft cable or similar wire from building structure from a minimum of TWO locations, independent of the ceiling system.

- I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

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

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within TWELVE months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to TWO visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 19

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SECTION 26 52 13

EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Product Schedule:

1. For all luminaires and exit signs, use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Provide seismic qualification certificate for each piece of equipment.

B. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: TEN percent of each type and rating installed. Furnish at least one of each type.
2. Luminaire-mounted, emergency battery pack: FIVE percent emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: ONE percent of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: ONE percent of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- C. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: TWO year(s) from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Power Unit Batteries: FIVE years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
 - 2. Warranty Period for Self-Powered Exit Sign Batteries: FIVE years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.

- E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
1. Emergency Connection: Operate one lamp or an equivalent number of LED's continuously at an output of no less than 50% of total lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Indoor Luminaires, 41 to 104 deg F.; Outdoor Luminaires, 5 to 104 deg F..
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- F. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate one lamp or an equivalent number of LED's continuously at an output of no less than 50% of total lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type.
 5. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the

distance recommended by the emergency power unit manufacturer, whichever is less.

6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires:
 1. Emergency Luminaires: Drawing designation as indicated in the Luminaire Schedule on Drawings, with the following additional features:
 - a. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations. Indoor and outdoor applications as shown on plans.
 - b. UL 94 flame rating.
- C. Emergency Lighting Unit:
 1. Emergency Lighting Unit: as indicated in the Luminaire Schedule on Drawings.
 2. Operating at nominal voltage matching lighting system.
 3. Wall, ceiling, or stem mounted with universal junction box adaptor.
 4. UV stable thermoplastic housing.
 5. Two LED lamp heads.
 6. Internal emergency power unit.
- D. Remote Emergency Lighting Units:
 1. Emergency Lighting Unit: as indicated on Drawings.
 2. Operating at nominal voltage matching lighting system.
 3. Wall, ceiling, or stem mounted with universal junction box adaptor.
 4. UV stable thermoplastic housing, provide wet location listing where shown outdoors.
 5. LED lamp heads.
 6. External emergency power unit.

2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:

1. Operating at nominal voltage as shown on plans.
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

- a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional battery capacity for power connection to remote units where shown.

C. Self-Luminous Signs:

1. Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 20 years.
2. Use strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

2.5 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Where recommended by luminaire manufacturer, attach to structural members in walls. Otherwise mount fixture to back box.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 26 52 13

SECTION 26 56 13

LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

1.2 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete luminaire.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

1.3 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) and luminaire-lowering device(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: FIVE years from date of Substantial Completion.

2. Warranty Period for Corrosion Resistance: FIVE years from date of Substantial Completion.

3. Warranty Period for Color Retention: FIVE years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

B. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 90 mph (40 m/s).

- C. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 METALLIC POLES

- A. Provide poles made of steel or aluminum, round or square, tapered or straight, as described on plans.
- B. Source Limitations: Obtain poles from single manufacturer or producer.
- C. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.
- D. Steel Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig. Where designated as stainless steel, comply with ASTM A 240/A 240M with a minimum yield of 55,000 psig. One-piece construction up to 40 feet in height with access handhole in pole wall.
 1. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- E. Mast Arms: Provide quantity of arms as described in plans, continuously welded to pole attachment plate. Material and finish same as pole.
- F. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- G. Fasteners: Stainless or Galvanized steel type, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
 1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- H. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.
- I. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

- J. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.
- K. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- L. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
 - 1. Color: As selected by Architect from manufacturer's full range.

2.3 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured with a minimum yield strength of **55,000 psi**.

2.4 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine poles, luminaire-mounting devices, , and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- B. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.
- B. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.3 POLE INSTALLATION

- A. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
 - 1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 2. Install base covers unless otherwise indicated.
 - 3. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- C. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

END OF SECTION 26 56 13

SECTION 26 56 19

LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for LED luminaires indicated in the Luminaire Schedule on the drawings.
- B. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

- b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- 7. LED driver or power supply product data sheets for each luminaire.

B. Shop Drawings: For nonstandard or custom luminaires.

- 1. Include plans, elevations, sections, and mounting and attachment details.
- 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Include diagrams for power, signal, and control wiring.
- 4. Where specifically indicated on plans, include photometric PxP drawings for areas where alternate fixtures are supplied.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of luminaire.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. One (1) copy of each approved submittal.
 - 2. Certificate of Material Receipt.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Drivers: TEN percent of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: ONE percent of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: ONE percent of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.

- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: FIVE year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Refer to Luminaire Schedule on drawings for Luminaire types and construction requirements.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- E. UL Compliance: Comply with UL 1598 and listed for wet location.
- F. LED lamps and driver shall have a rated life of minimum 50,000 hours.
- G. LED driver shall meet ANSI C62.41 Category. A surge protection standard up to 4 kV.
- H. CRI of minimum 80. CCT of 4000K unless otherwise noted.
- I. Ambient Temperature: LED Luminaire shall be rated from 5 deg F to +104 deg F.
- J. In-line Fusing: Separate in-line fuse for each luminaire.
- K. LED Lamp Module Rating: Lamp marked for outdoor use.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE TYPES

- A. Provide types as indicated in Luminaire Schedule and as indicated on drawings.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Metal Components: As indicated in Luminaire Schedule. Form and support to prevent warping and sagging.
- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.4 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and - tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Finish Color: Unless otherwise noted, color shall be selected by the architect. Provide color chip samples or selection sheet with shop drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Where recommended by luminaire manufacturer, attach to structural members in walls. Otherwise mount fixture to back box.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

3.5 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain luminaires and any photocell relays.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within the warranty period, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions.

Make up to TWO visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace LED module, driver or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 56 19

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding rods.
 - 5. Grounding labeling.

1.2 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. EMT: Electrical metallic tubing.
- C. TGB: Telecommunications grounding busbar.
- D. TMGB: Telecommunications main grounding busbar.
- E. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Qualification Data: For Installer
- C. Qualification Data: For testing agency and testing agency's field supervisor.

- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as an ITS Installer 2 to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with ANSI/TIA-607-C.
- D. NEC 2017

2.2 CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Harger Lightning and Grounding.
 - 2. Panduit Corp.

3. Tyco Electronics Corp.
4. Burndy

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

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

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.
4. Burndy

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

- F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth Products, Inc.
 - 2. Harger Lightning and Grounding.
 - 3. Panduit Corp.
 - 4. Burndy
- B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, minimum length 20 inches or as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with UL 467, and shall comply with TIA-607-C.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a minimum of 2 inches separation from the wall to the back to the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-C.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch separation from the wall to the back of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-C. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-C.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 2 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 2 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than **No. 3/0 AWG**.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
 - 4. Each connector shall be secured to the TMGB / TGB with a minimum of two bolts
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor.
 - 1. **If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.**
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-horizontally mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors. Daisy chaining or serial connection from one rack or cabinet to another is not acceptable.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TMGB/TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TMGB/TGB in communications rooms and spaces. Comply with TIA-568-B.1 and TIA-568-B.2 when grounding shielded balanced twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section. Each individual patch panel shall be installed with at least one green thread-forming bonding screw and bonded to the equipment rack / cabinet ground bar.

3.7 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.

2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB. Maximum acceptable ac current level is 1 A.
- D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds **5** ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 27 05 26

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Hooks.
 - 3. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RNC: Rigid nonmetallic conduit

1.3 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Tele-power poles.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Underground handholes and boxes.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit.
 3. O-Z/Gedney.
 4. Robroy Industries.
 5. Southwire Company.
 6. Thomas & Betts Corporation.
- C. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. IMC: Comply with ANSI C80.6 and UL 1242.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: set-screw, compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Legrand – Cablofil.
 2. Cooper B-Line.
 3. Panduit
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized or stainless steel.
- F. J shape.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Technologies Company; Cooper Crouse-Hinds.
 2. Hoffman.
 3. O-Z/Gedney.
 4. Quazite:Hubbell Power Systems, Inc.
 5. RACO; Hubbell.
 6. Thomas & Betts Corporation.
- C. General Requirements for Boxes, Enclosures, and Cabinets:
 1. Comply with TIA-569-D.
 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep

5. Audio / Visual Device Box Dimensions: Per equipment manufacturer requirements or as indicated on drawings.
 6. Gangable boxes are prohibited.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
 - E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
 - F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
 - G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
 - H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
 - I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Nonmetallic Enclosures:
 - a. Material: Plastic
 - b. Finished inside with radio-frequency-resistant paint.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed Conduit: RNC, Type EPC-40-PVC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Mechanical rooms, Garage.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT
 4. Damp or Wet Locations: ARC.
 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT .
 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT

- C. Dwelling Units: Communication system cabling may run open wired where concealed within walls or ceiling.
- D. Minimum Pathway Size: 3/4-inch trade size communication cables. Conduit fill shall not exceed code requirements.
- E. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use set-screw or compression fittings with insulated throats. Comply with NEMA FB 2.10.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface pathways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. ANSI/BICSI N1.
 - 3. TIA-569-E.
 - 4. NECA 101
 - 5. NECA 102.
 - 6. NECA 111.
- B. Pathways shall not exceed 40% fill rate at the completion of the project.
- C. Do not share pathways for voice and data systems with other low voltage cabling.
- D. Provide conduits in inaccessible environments, including but not limited to above drywall ceilings, in walls, above HVAC ductwork, fume hoods, lab counters and cabinets.
- E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- F. Complete pathway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Provide pull-box for any conduit run that exceeds 100 feet.
- I. LB fittings are not permitted in lieu of pull boxes.

- J. Install no more than the equivalent of three 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- K. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- L. Support conduit within 12 inches of enclosures to which attached.
- M. All conduits shall have insulated bushings.
- N. Conduits for backbone cabling routed to MTR and TR's shall end adjacent in a corner of room where multiple sheets of plywood backboard are installed. Secure conduits to backboard when entering room from above. Extend conduits from below 4 inches above finished floor.
- O. Maintain the following clearances between pathways and possible sources of electromagnetic interference exceeding 5 KVA:
 - 1. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway: 6"
 - 2. Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway: 12"
 - 3. Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways: 24"
 - 4. Electrical motors and transformers: 47"
- P. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- Q. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- S. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- T. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- U. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- V. Set metal floor boxes level and flush with finished floor surface.

- W. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- X. All pull boxes shall be accessible. Do not place above drywall ceilings, HVAC ductwork or piping.

3.3 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

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SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
4. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Equipment supports.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Items penetrating finished ceiling, including the following:

- a. Luminaires.
- b. Air outlets and inlets.
- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- f. Projectors.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Eaton's B-Line Series – Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 2. Standard: All products shall be by an American manufacturer and be Underwriters Laboratories (UL) listed.
 3. Comply with MFMA-4 factory-fabricated components for field assembly.
 4. Material for Channel, Fittings, and Accessories: Galvanized steel. Where installed outdoors or subject to corrosion, stainless steel supports shall be provided.
 5. Channel Width: Select for applicable load criteria, minimum size 1-5/8 inches.
 6. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 9. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- D. Mounting, Anchoring, and Attachment Components: Items for fastening communication items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. ANSI/BICSI N1
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, control enclosures, pull and junction boxes, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
 - 2. See additional requirements where painting specification are included as part of this project.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 27 05 29

SECTION 27 05 44

SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.2 ACTION SUBMITTALS

- ###### A. Product Data: For each type of product. All products shall be by an American manufacturer and be Underwriters Laboratories (UL) listed.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- ###### B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- ###### C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- ###### D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- ###### E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- ###### F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

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

END OF SECTION 27 05 44

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-C.

B. Comply with ANSI Z535.4 for safety signs and labels.

- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.
 - 2. Provide for equipment racks and patch panels

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, OPTICAL-FIBER CABLE".

C. Tag: Exterior Communications Pathways

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 5 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 28 lb/1000 sq. ft..
6. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

2.5 SIGNS

A. Laminated-Acrylic or Melamine-Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. in, minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, Architect, and Owner's Project Manager.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- I. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- K. Underground-Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify cables, and terminals in enclosures and at junctions, terminals, pull points, when entering and exiting the cable tray, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system name.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, composed of the following, in the order listed:
 - 1. TR room number
 - 2. Dash
 - 3. 4-digit number, first digit will identify the floor that the TO is located, and following 3 digits to patch-panel port
 - 4. Confirm all labeling schemes with Owner's representative prior to implementation.
- E. Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing TR room number and equipment designation.
 - 2. Patch Panels: Label patch panels sequentially, from left to right on the panels with self-adhesive labels.
 - 3. Confirm all labeling schemes with Owner representative prior to implementation.
- F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- G. Horizontal Cables: Label each cable with a vinyl-wraparound label or self-adhesive wraparound label indicating the following, in the order listed:
 - 1. TR-Room number.
 - 2. Dash
 - 3. Faceplate 4-digit number.
- H. Instructional Signs: Self-adhesive labels.
- I. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 2. Equipment to Be Labeled:
 - a. Communications cabinets.

END OF SECTION 27 05 53

SECTION 27 11 16

COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. backboards
 - 2. 19-inch equipment racks.
 - 3. Power strips.
 - 4. Grounding.
 - 5. Labeling.

1.2 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. TGB: Telecommunications grounding bus bar.
- F. TMGB: Telecommunications main grounding bus bar.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.
- B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 1. The Contractor must hold a current certification from the manufacturer of the proposed connectivity solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties as specified. All technicians working on the project will have manufacturers training and training certificates.
 2. The cabling contractor must have a minimum of five (5) years of documented experience installing structured cabling systems.
 3. Installation personnel shall consist of 100% BICSI certified staff and listed on the BICSI website. There shall be at least one BICSI certified Technician during all cable installation work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL listed.
- B. RoHS compliant.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

2.3 19-INCH EQUIPMENT RACKS

- A. Description: Two post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. Manufacturers:

1. Basis of design shall be Chatsworth
2. Approved equal by Panduit, Hubbell, Atlas, Middle Atlantic

C. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.
5. UL Listed: UL 1863

D. Floor-Mounted Racks:

1. Basis of Design – Chatsworth 55053-X03, 7', 45RU, Two-Post Rack
2. Overall Height: 84 inches.
3. Overall Width: 20.25 inches
4. Upright Depth: 3 inches.
5. Two-Post Load Rating: 500 lb unsecured, 1000 lb bolted to floor.
6. Number of Rack Units per Rack: 45.
 - a. Numbering: Every rack units, on interior of rack.
7. Threads: #12-24.
8. Vertical and horizontal cable management channels, top and bottom cable troughs, horizontal rack bonding bus bar, and a power strip.
9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
10. Top shall have provisions for attaching to cable tray or ceiling.
11. Self-leveling.

E. Vertical Cable Management:

1. Manufacturers:
 - a. Basis of Design – Chatsworth, Evolution G2, 35497-X02
 - b. Hubbell #VM610 vertical manager with #ICKSS6 spindles
 - c. Pre-approved equal
2. Metal, with integral wire retaining fingers.
3. Baked-polyester powder coat finish, black.
4. Hinged left & right removable doors.
5. 84 inched (full height of rack) x 6 inches x 10.8 inches
6. Two vertical wires managers per racks
7. Single vertical wire manager may be provided between racks if it is sized to the cable requirements for both racks.

F. Horizontal Cable Management:

1. Manufacturers:
 - a. Basis of Design – Chatsworth Evolution, #35441-X02, 2RU.
 - b. Hubbell #HM27C
 - c. Pre-approved equal

2. Metal, with integral wire retaining fingers.
3. Baked-polyester powder coat finish, black.
4. Hinged removable door.
5. 2 RU's, 7 inches depth
6. Minimum 3 per rack; provide greater quantity as required for complete system
7. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 1. Manufacturers:
 - a. Hubbell #PR10420 power strip with #PRSLB4 mounting bracket
 - b. Pre-approved equal
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Rack mounting with standoff brackets to provide 6 inches of separation from cable management system.
 4. 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles. Provide quantity of receptacles required to accommodate all rack mounted equipment

2.5 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Rack Rail Grounding Strip: 0.67" width x 78.65" long to accommodate 45RU rails.
 1. Rack-Mounted Vertical Strap: Basis of Design – Panduit RGS134-1Y. Designed for mounting in 19- equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.6 LABELING

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 270553 "Identification for Communication Systems".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.

- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Support floor mounted racks at the top by the cable tray system.
- F. Install racks and cable tray so that the cable tray water fall works properly.
- G. Backboards:
 - 1. Provide backboards for all wall of MTR's and TR's.
 - 2. Install with 96-inch dimension vertical, 12 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 - 3. Butt adjacent backboards sheets tightly to form smooth gap free corners and joints.
 - 4. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.
 - 5. Route and mount only communications cabling and equipment on the backboard.
 - 6. Backboards shall remain unpainted. If painted, they shall be replaced at the Contractor's expense.
- H. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with Owner.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
 - 5. Install racks so that there is a minimum of 3 feet of clearance at the back of the rack (measured from back of installed switches) and 3 feet clearance at the front of the rack (measured from installed equipment face), and 3 feet clearance at one side of the rack.
- I. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.

- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Chapter.
- C. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems"
- D. Connect each rack TGB to near room TGB or the TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-C. Comply with requirements in Section 270553 "Identification for Electrical Systems."

END OF SECTION 27 11 16

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. CATV COAXIAL Cable
 - 4. COAXIAL cable hardware.
 - 5. Cable management system.
 - 6. Cabling identification products.

1.2 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. an "outlet," it is the fixed, female connector.
- C. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- D. RCDD: Registered Communications Distribution Designer.
- E. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- F. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- G. S/FTP: Overall braid screened cable with foil screened twisted pair.
- H. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- I. UTP: Unscreened (unshielded) twisted pair.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

2. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
 3. Cabling Contractor must have minimum of five years of documented experience installing structured cabling systems.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI as an RCDD on staff.
1. Testing Agency's Field Supervisor: Currently certified by Fluke as Certified Cabling Test Technician, or Owner approved equal.
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Test cables upon receipt at Project site.
1. Test each pair of twisted pair cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Grounding: Comply with TIA-607-C.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
1. Communications, Plenum Rated: Type CMP complying with UL 1685

2.3 CATEGORY 6 and CATEGORY 6A TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz and Category 6A at frequencies up to 500MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Inc. #C6RRB; NEXTSPEED Category 6A.
 2. Panduit
 3. Belden
 4. CommScope
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 and Category 6A UTP cables.

- D. Conductors: 100-ohm, 23 AWG solid copper, 4-twisted pairs.
- E. Shielding/Screening: Unshielded twisted pairs (UTP)
- F. Cable Rating: Plenum.
- G. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Inc.
 - 2. Pre-approved equal by Panduit or Belden
- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6 and Category 6A.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- E. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568-C.2.
 - 3. Marked to indicate transmission performance.
- F. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standard: Comply with TIA-568-C.2.
 - 4. Marked to indicate transmission performance.
- G. Faceplate:
 - 1. Two, Four or Six port, vertical single gang faceplates designed to mount to single gang wall boxes.

2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

H. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CATV COAXIAL CABLE

- A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

B. Manufacturers:

1. Alpha
2. Belden Inc.
3. Coleman Cable
4. CommScope
5. Prysmian

- C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:

1. RG-6/U: UL Type CATVP.
 - a. No. 18 AWG, solid, copper-covered steel conductor.
 - b. Plenum rated.
 - c. Gas-injected, foam-PE insulation.
 - d. Shielded with 100 percent aluminum tape and 40 percent aluminum braid.
 - e. Jacketed with black PVC or PE.
 - f. Suitable for indoor installations.
2. RG-11/U: UL Type CATVP.
 - a. No. 16 AWG, solid, copper-covered steel conductor.
 - b. Plenum rated.
 - c. Gas-injected, foam-PE insulation.
 - d. Shielded with 100 percent aluminum tape and 40 percent aluminum braid.
 - e. Jacketed with black PVC or PE.
 - f. Suitable for indoor installations.
- 3.

2.6 COAXIAL CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

- C. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.
- D. Patch Cords: Factory-made cables terminated with a male Type BNC connector at each end.
- E. Faceplates:
 - 1. Plastic Faceplate: Coordinate color/material with Section 262726 "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
 - a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.

2.7 SOURCE QUALITY CONTROL

- A. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in free-air where concealed within wall or ceilings within the dwelling units. Cable shall be supported.

3.2 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 2. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
- C. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

3.3 FIELD QUALITY CONTROL

- A. Testing instrument shall be Fluke Versiv #DSX-5000 or Owner approved equal.

1. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2.
 2. Test instrument shall be within its 12 month calibration period.
 3. Test instrument shall have most current software and firmware versions installed.
 4. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 5. If test instruments do not meet these requirements at the time of scheduled testing, testing will not take place and will be rescheduled.
- B. Installation of whole system must be complete prior to testing, including pathways, firestopping, all cabling dressed, labeling, devices, and faceplates.
- C. Marginal tests shall not be accepted.
- D. Testing shall be performed on each cabling segment, connector to connector. Sampling testing is not acceptable.

END OF SECTION 27 15 13

SECTION 27 20 10

LOCAL AREA NETWORK ELECTRONICS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install a complete network electronics package to support the facility and as described below and as shown on the drawings.
- B. Work of this section includes the design and installation of a complete turnkey network electronics system and the necessary coordination with the The Guild's IT Manager to understand the performance intended with the proposed components identified. The work is to include the training of the The Guild's designated personnel including training aids that use the actual equipment installed.
- C. Work of this section includes performance testing and commissioning.
- D. Components of the network include, but are not limited to the following:
 - 1. POE Network switches including power supplies, supervisor engines (if applicable) and cooling fans.
 - 2. Switch uplink cards with 1GbE, dual, LC connectors for fiber optic cable connectivity, 1GbE ports for copper cable connectivity.
 - 3. Cable and port management, labeling and electronic record keeping.
 - 4. Interconnecting cabling and connectors.
- E. The Contractor shall provide all labor, material, equipment, accessories, operating system, software, licensing, connections, configuration, service agreement and all misc. components necessary for a complete operational network electronics system in accordance with this specification and network diagrams in the contract documents.
- F. The Contractor shall provide in his bid for configuration and provisioning of active ports and complete testing of the Data Network System. Coordinate configuration, addressing and subnetting with the The Guild's assigned IT representative prior to installation.
- G. Install an SNMP based network management software package allowing full management of all local area network electronics. Configure to allow a remote site to remotely access the network as directed by the The Guild IT representative.
- H. Provide as part of this contract 40 hours of on-site training and demonstration of the system to individuals indicated and selected by the Owner.

1.2 LOCAL AREA NETWORK SYSTEM DESCRIPTION

- A. Provide an Ethernet, Two-Tier or Three-Tier Hierarchical model with Core/Gateway and Access Layers. Access layer switches shall be multiple Layer 3 capable stackable switches.
- B. Connectivity from the service provider is expected to be single mode fiber optic cabling utilizing duplex LC connectors.
- C. Core/Gateway switches shall have sufficient 10Gb/s, SFP, fiber optic ports to provide one, 10Gb/s uplink to each TR in the project. If 10Gb/s ports are insufficient, provide fiber optic aggregation switch. Connectivity from core switches to aggregation or access switches is expected to be OM4, multimode fiber optic cabling utilizing duplex LC connectors.
- D. Aggregation switches shall have sufficient 10Gb/s fiber optic ports to provide one, 10Gb/s uplink to each TR in the project. Provide SFP, 10Gbps Multi-Mode Optical Modules in quantity to match all TR's plus two spare units.
- E. All uplinks shall be capable of 10Gb/s data transmission over installed 50 μ m, OM4, multimode backbone fiber between telecommunications rooms (TR). Backbone fibers and fiber patch cables shall be terminated in "LC" fiber optic connectors.
- F. Access layer switches shall have 8P8C (RJ45) ports for connectivity of network access appliances. Ports shall be capable of 100/1000 Mb/s data transmission via Cat 6, 4 PR UTP cabling between the switches and patch panels serving data jacks/ports in the work areas. All 8P8C ports shall provide IEEE 802.3at-2009 compliant, Power over Ethernet+ capability.

1.3 ACTION SUBMITTALS

- A. Provide a Compliance Review of the Specifications. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications with the following information; "C", "D" or "E" marked in the margin of the original Specifications and any subsequent Addenda.
 - 1. "C": Comply with no exceptions.
 - 2. "D": Comply with deviations. For every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
 - 3. "E": Exception, do not comply. For every exception, provide a numbered footnote with reasons and possible alternative.
- B. Basis of Design router and security gateway feature and performance comparison table and compliance review.
 - 1. Basis of Design unit is Ubiquiti UDM SE Dream Machine Special Addition.
 - 2. Dual WAN Ports (10G SFP, 2.5GB 8p8c)
 - 3. 8-GbE ports, including 6-POE and 2-POE+ Lan ports.
 - 4. 1.7GHz quad-core processor.
- C. Basis of Design Aggregation Switch feature and performance comparison table and compliance review.

1. Basis of Design Unit is Ubiquiti Switch Pro Aggregation.
 2. Layer 3 Switch with 28-10G SFP+ ports and 4-25G SFP28 ports.
 3. 760Gb/s switching capacity.
 4. Provide SFP, 10Gbps Multi-Mode Optical Modules in quantity to match all TR's plus two spare units.
- D. Basis of Design network switch feature and performance comparison table and compliance review.
1. Basis of Design unit is Ubiquiti Switch Pro 48 (USW Pro48) and Switch Pro 48 POE (USW Pro 48 POE) for POE applications.
 2. Layer 3 switch with 48 GbE 8P8C ports
 3. POE Version is 48 GbE 8P8C ports, 40-POE+ ports and 8-POE++ ports
 4. 600W total of POE power.
- E. Shop Drawings
1. Submit catalog cuts of products in indexed, book binder form for review.
 2. "Clean" and "approved" product cut sheets including catalog information, sizing, and technical data on each item to be utilized on the Project.
- F. Network Diagram
1. Prepare and submit a network electronics connectivity diagram in AutoCAD format.
 2. Indicate all connectivity points between system components and link types.
- G. Equipment Inventories by Site in electronic format.
- H. Operations and Maintenance Manuals.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- 1.5 QUALITY ASSURANCE
- A. The Contractor shall possess Silver Certified Partner certification from the equipment manufacturer.
- B. All information technology and data processing equipment and peripherals shall be listed by Underwriters Laboratories, Inc. or other recognized independent testing laboratory.
- C. Installing Contractor must have minimum 3 years' experience in computer network installations.
- D. Contractor shall submit with his Bid a list of projects performed in the past 2 years, similar to one specified herein.

PART 2 - PRODUCTS

2.1 PRECEDENCE

- A. The data network contractor must review the Specifications carefully and must provide the latest generation of equipment that meets or exceeds performance criteria outlined in these specifications.
- B. If the Contractor bids products that do not meet or exceed the performance specifications or the original specified design-basis model, the Contractor shall provide products that meet the performance specifications as approved by the Architect/Engineer at no additional cost to the project.

2.2 MANUFACTURERS

- A. Subject to compliance with desired performance guideline requirements, provide network electronics equipment by one of the following.
 - 1. Basis of Design – Ubiquiti Pro or Enterprise series.
 - 2. Or, HP Aruba, 2930F, 48G, POE+, 4SFP (JL256A) for POE Switches (SWP on drawings) and HP Aruba, 2930F, 48G, 4SFP (JL254A) for non-POE switches (SW1 on drawings).
 - 3. Equivalent by Dell Force 10 Networks.
 - 4. Equivalent by Cisco.

2.3 PRODUCTS

- A. Core Gateway / Stackable Switch
 - 1. Minimum of One Core gateway / stackable switch shall be provided in telecom room M1A, rack R1.
 - 2. Basis of Design unit is Ubiquiti UDM SE Dream Machine Special Addition.
 - 3. Dual WAN Ports (10G SFP, 2.5GB 8p8c)
 - 4. 8-GbE ports, including 6-POE and 2-POE+ Lan ports.
 - 5. 1.7GHz quad-core processor
- B. Aggregation Switch
 - 1. Minimum of One aggregation switch shall be provided in telecom room M1A, rack R1.
 - 2. Layer 3 Switch with 28-10G SFP+ ports and 4-25G SPF28 ports.
 - 3. 760Gb/s switching capacity.
 - 4. Provide SFP,10Gbps Multi-Mode Optical Modules in quantity to match all TR's plus two spare units
- C. Access Layer Stackable Switches
 - 1. Minimum of One Access Layer stackable switch shall be provided in each TR in the facility including telecom room M1A, rack R1. Increase quantity as required to serve all devices in the serving zone plus allow for 10 spare ports.
 - 2. Basis of Design unit is Ubiquiti Switch Pro 48 POE (USW Pro 48 POE) for POE applications. Additional switches in each serving zone are expected to be non-POE, Switch Pro 48 (USW Pro48).

3. Layer 3 switch with 48 GbE 8P8C ports
4. POE Version is 48 GbE 8P8C ports, 40-POE+ ports and 8-POE++ ports
5. 600W total of POE powerPerformance.

D. Wireless Access Points and Controllers

1. Radio Frequency Study
 - a. Location and quantity of wireless access points on plans is approximate. Perform and submit radio frequency study for review to engineer prior to rough-in and installation of wireless access points.
 - b. Provide allowance in bid for up to 15% additional wireless access points and associated equipment to conform with results of RF study.
2. Wireless Access Points
 - a. Furnish and install 802.11 a/b/g/n/ac Wave2, Wifi 6 wireless access points and associated required wireless access point controllers (included in the Ubiquiti gateway).
 - b. Provide one, 1GB/s connection from switches / patch panels in the TR's to each wireless access point over Cat6A cabling to allow for future migration to 10Gb/s. Coil 15' of extra cable above ceiling near each access point.
 - c. Provide and install Wireless Access points similar to Ubiquiti Unifi6 Pro.
3. Controllers
 - a. Furnish and install wireless access point controller(s) as required for quantity of wireless access points provided. If the Basis of design Ubiquiti UDM-SE gateway is used, it includes the wireless access point controllers.

E. Fiber Optic Patch Cords

1. Fiber optic patch cords shall be tested to meet the following criteria:
 - a. Minimum Effective modal bandwidth of at least 4700 MHz·km at 850 nm.
 - b. Overfilled modal bandwidth of at least 3500 MHz·km at 850 nm.
 - c. Overfilled modal bandwidth of at least 500 MHz·km at 1300 nm.
2. 10Gbps data carrying capacity.
3. PVC jacket with molded plastic boot. Aqua color for OM4 multimode, Yellow for single mode.
4. Factory fabricated with duplex LC connectors on each end.
5. Provide patch cords in lengths to properly span the distance from the fiber backbone patch panels in each TR to each network electronic device in the same TR.
6. Provide two spares of each type patch cord per each network switch.

F. Copper Patch Cords.

1. Copper patch cords shall be tested to meet a minimum rating of Category 6.
2. Patch cords shall be 8-conductor, stranded, copper patch cords with factory installed eight-pin, eight conductor (8P8C) jacks and boots with straight-through T568B pin configuration.
3. Provide one patch cord between switches and patch panels for each active switch port in each TR.
4. Provide in lengths of 4 feet, 7 feet, 10 feet, etc. for proper cable management without excessive length.
5. Provide two spares of each type patch cord per each network switch.
6. Patch cords shall be provided by this contractor only in the TR's and wireless access points. Work area patch cords shall be provided by desktop computer or peripheral suppliers, not this contractor.

7. Patch cord color to match jack on patch panel. See drawings for patch cord color requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Stackable switches: Install stackable switches complete in each TR per manufacturer's instructions and the contract documents.
- B. Provide all miscellaneous equipment such as patch cords and cable management to connect the switches, both copper and fiber for a complete TURNKEY system.
- C. Testing.
 1. The Contractor shall be responsible for energizing and testing each port and verify, in writing, that the computer network system is in proper working condition.
 2. Each port must be tested for proper operations.
 3. The Guild Office of Computer Services to furnish the configuration for this Contractor.
- D. Support floor mounted racks at the top by the cable tray system.
- E. Install racks and cable tray so that the cable tray water fall is oriented properly.
- F. Backboards:
 1. Provide backboards for all wall of MTR's and TR's.
 2. Install with 96-inch dimension vertical, 12 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 3. Butt adjacent backboards sheets tightly to form smooth gap free corners and joints.
 4. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.
 5. Route and mount only communications cabling and equipment on the backboard.
 6. Backboards shall remain unpainted. If painted, they shall be replaced at the Contractor's expense.
- G. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with Owner.
 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications,

electronic safety and security, and related systems that share space in equipment room.

5. Install racks so that there is a minimum of 3 feet of clearance at the back of the rack (measured from back of installed switches) and 3 feet clearance at the front of the rack (measured from installed equipment face), and 3 feet clearance at one side of the rack.

- H. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Chapter.
- C. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems"
- D. Connect each rack TGB to near room TGB or the TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-C. Comply with requirements in Section 270553 "Identification for Electrical Systems."

END OF SECTION 27 20 10

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SECTION 27 51 23

SOUND REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Loudspeakers
 - 2. Conductors and cables.
 - 3. Raceways.

1.2 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Bogen
- B. JBL
- C. Electro-Voice
- D. Polk

2.2 CEILING SPEAKERS

- A. Speaker shall be ceiling mounted and consist of one 6-1/2" (nominal) low frequency transducer, one 1" (nominal) high frequency transducer, and a filter network for dividing frequencies between the transducers. The front baffle shall be injection-molded ABS material and the back can (enclosure) shall be plated steel. All components shall be mounted inside the enclosure. A perforated steel speaker grille shall be provided, color-matched to the baffle.
- B. Frequency Response: 65 Hz to 19 kHz.
- C. High impedance tap selections of 1, 2, 4, 8, 16, and 32 W.

- D. Enclosure: Heavy gauge steel housing.
- E. Dimensions: 12-5/16" diameter x 12" deep.
- F. Color: White
- G. Basis of Design: See plans.
- H. Mounting accessories shall be as required by the manufacturer.

2.3 WALL AND POLE MOUNT SPEAKERS

The speaker shall consist of one 8-inch nominal low frequency transducer and one 1-1/8-inch nominal titanium high frequency transducer with a filter network for dividing frequencies between the transducers. A weather-tight enclosure shall house all components. The enclosure shall be constructed from an injection-molded, high density (30% or greater) mineral-filled polypropylene material compounded with UV inhibitors. Speaker shall be rated for exterior use.

- A. Frequency Response: 45 Hz to 17 kHz.
- B. Power Output: 175 W.
- C. Enclosure: Heavy gauge stainless steel housing. Perforated speaker grills shall be made from heavy-gauge PVC, color-matched to the speaker enclosure.
- D. Dimensions: 17-7/8" W x 10-1/4" H x 10" D.
- E. Color: Black
- F. Basis of Design: See plans.
- G. Mounting accessories shall be as required by the manufacturer.

2.4 CONDUCTORS AND CABLES

- A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
- B. Insulation: Thermoplastic, not less than 1/32 inch thick.
- C. Shielding: For speaker-microphone leads and elsewhere as recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
 - 1. Minimum Shielding Coverage on Conductors: 60 percent.
- D. Plenum Cable: Listed and labeled for plenum installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems"" for installation of conduits and wireways.
- C. Wiring Method: Install cables in raceways where otherwise inaccessible. Conceal raceway and cables except in unfinished spaces.
- D. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides (j-hooks) where located above accessible ceiling.
 - 2. Suspend cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
 - 3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
- E. Separation of Wires: Separate speaker and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart.
- F. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

END OF SECTION 27 51 23

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SECTION 28 13 00

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 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. CPU: Central processing unit.
- C. Credential: Data assigned to an entity and used to identify that entity.
- D. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- E. GFI: Ground fault interrupter.
- F. Identifier: A credential card. Where this term is presented with an initial capital letter, this definition applies.
- G. I/O: Input/Output.
- H. LAN: Local area network.
- I. Location: A location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-B communications loop. Where this term is presented with an initial capital letter, this definition applies.
- J. PC: Personal computer. Applies to the central station, workstations, and file servers.
- K. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.
- L. RAS: Remote access services.
- M. RF: Radio frequency.
- N. ROM: Read-only memory. ROM data are maintained through losses of power.

- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. USB: Universal serial bus.
- Q. WAN: Wide area network.
- R. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- S. Windows: Operating system by Microsoft Corporation.
- T. Workstation: A PC with software that is configured for specific, limited security-system functions.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Microsoft Windows software documentation.
 - 2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.

3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Credential card blanks, ready for printing. Include 1000 credential cards for all personnel to be enrolled at the site.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.
- 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 NFPA 70, "National Electrical Code."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
 1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
 3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
 4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
 3. Indoor, Uncontrolled Environment: NEMA 250, Type 12 enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
 4. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of access control system that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three (3) years from date of project completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Lenel NetBox Extreme. Provide all peripheral devices, equipment, and associated wiring.
- B. Card readers shall be proximity type readers, HID Model # RP40
- C. Request to Exit detectors are Kantech by Tyco, T.Rex.
- D. Parking Garage Entry long range RFID readers shall be AWID, LR-3000.
- E. Other manufacturers are not acceptable.

2.2 PERIPHERALS

- A. The system shall allow the use of commercial, off-the-shelf printers and digital cameras for the capture of identification photos and printing of identification badges and system activity reports.

2.3 WARRANTIES

- A. The product warranty to the user warrants the equipment to be free from defects in material and workmanship for the following time period from the date of purchase.
- B. A two-year no questions asked warranty for the replacement of product only for the controller, I/O Expansion Boards, and Reader Interface Modules.
- C. A limited lifetime warranty for the Mullion, Euro, and Wall Switch Readers.
- D. A limited lifetime warranty for standard "Clamshell" Proximity Cards and Key Tags.
- E. A one-year warranty for the ISO Card.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine rough-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA/EIA 606-B, "Administration Standard for Telecommunications Infrastructure."
- C. Obtain detailed Project planning forms from manufacturer of access control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
 - 1. Record setup data for control station and workstations.
 - 2. For each Location, record setup of controller features and access requirements.

3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
 4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
 5. Assign action message names and compose messages.
 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
 7. Prepare and install alarm graphic maps.
 8. Develop user-defined fields.
 9. Develop screen layout formats.
 10. Propose setups for guard tours and key control.
 11. Discuss badge layout options; design badges.
 12. Complete system diagnostics and operation verification.
 13. Prepare a specific plan for system testing, startup, and demonstration.
 14. Develop acceptance test concept and, on approval, develop specifics of the test.
- D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.3 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- C. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.
- D. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- E. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

- A. Comply with TIA 569-D, "Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. (15 m).
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).
- E. Card Readers:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. (75 m).
- G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. (8 m).

3.5 GROUNDING

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

- A. Install card readers, power supply units, controllers, and all interconnecting wiring, boxes, and conduits.

3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA 606-B.
- B. Develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

3.8 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 6 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
 - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
 - 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for

end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 - 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. Provide minimum of 16 hours of training.
- B. Develop separate training modules for the following:
 - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
 - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
 - 3. Security personnel.
 - 4. Hardware maintenance personnel.
 - 5. Corporate management.
- C. All training sessions shall be coordinated with the owner's representative for dates and times. Provide two (2) DVD copies of training sessions.

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SECTION 28 13 53

VIDEO INTERCOM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. IP Multi-tenant video intercom system.

1.2 RELATED SECTIONS

- A. Section 28 18 00 - Access Control System.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Subject to compliance with requirements, provide BUTTERFLY MX or compatible product by one of the following:
 - 1. Aiphone
 - 2. Mircom

2.2 VIDEO INTERCOM STATION GENERAL REQUIREMENTS:

- A. Video intercom station shall allow visitors, residents, and staff to communicate with building residents and release exterior doors using valid credentials. Product manufacturer shall support cloud-based app for use with resident cellular phones. The intercom station shall be capable of initiating two-way audio and one-way HD video calls to cell phones using the app. Video intercom station shall utilize onboard HD video camera. Once a call is placed, visitor is displayed within resident cell phone app using the intercom station camera. Resident has the option to initiate video from their cell phone for two-way video and audio communication. Alternatively, intercom can initiate two-way audio calls to land lines. This system does not utilize hardwired resident intercom stations.
- B. Video intercom system shall feature a graphical user interface to allow visitors to call the admin office, call resident, or search the resident directory.
- C. Video Intercom System shall be web based and allow administrator privileges using username and password security. Administrators shall be able to program system remotely including add/subtract users (residents and staff).
 - 1. System shall support no less than 9,000 users.

- D. Web based data logger shall log all interactions with intercom stations. Each interaction shall be time-stamped and include photo of user captured at the time of use.
- E. Valid Credentials used to open exterior doors using the video intercom system include app-based door release, user programmed PIN code, and admin programmed delivery PIN code used for package handlers or other vendors.
- F. Video intercom system shall have the following features:
 - 1. Touchscreen control panel, LCD TFT with 600 x 800 minimum resolution.
 - 2. IP video camera; 2MP resolution or greater.
 - 3. Panel mounted speaker and microphone for audio communication.
 - 4. Searchable resident directory.
 - 5. N.O/N.C. contacts to allow signal to local electrified lockset to release doors upon presentation of valid credential.
- G. Intercom stations shall be weatherproof and vandal resistant for use outdoors. Operating temperature range; 0 deg F – 120 deg F.
- H. Intercom stations shall feature recessed enclosures with flush installation and tamper proof hardware.

2.3 INTERCOM STATION TYPES:

- A. Master video intercom stations shall feature an 11" touch screen.
 - 1. Station shall operate at 120V.
 - 2. Station shall feature RJ-45 jack for connection to local network using CAT 6 cable.
 - 3. Station shall feature contacts for two-wire connection to local electrified door hardware.
- B. Remote video intercom stations shall have the same features as the master station but utilize a smaller 7" touch screen.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.

- B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.3 SET-UP AND ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.4 DEMONSTRATION AND TRAINING

- A. Demonstration:
 - 1. Demonstrate that integrated security and communication system functions properly.
 - 2. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Instruction and Training:
 - 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - 3. Provide instruction and training by qualified representative of manufacturer.

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SECTION 28 15 00

ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Server hardware and access control software, web-based client software.
2. Access control panels.
3. Credential creation and management system; access control photo credentials.
4. Access control card readers.
5. Cables
6. Transformers

B. Related Requirements:

1. UL 294 Access Control System Units
2. NFPA 70 2017, National Electrical Code
3. NFPA 72 National Fire Alarm Code
4. NFPA 101, Life Safety Code.

1.2 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

- E. PC: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.
- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - d. Local door Controllers
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on USB media of the hard-copy submittal.
 - 2. System installation and setup guides with data forms to plan and record options and setup decisions.
 - 3. As-Built drawings.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
- B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
- C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
- D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.

2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers: Basis of Design: Lenel, S2 Security, Honeywell, Siemens, Stanley Security.
- B. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

- A. Card Readers:
 1. Card readers shall be HID RP40 series card readers.
 2. Mullion mounted card readers shall be HID MiniProx 5365Card-Reader, Vicon VAX-300 series or equal.
 3. Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
- B. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
 1. Indoors, controlled environment.
 2. Indoors, uncontrolled environment.
 3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
 4. Operating Temperature: -40°F to +149°F (-40° C to +65° C).

- C. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- D. Proximity cards shall be HID iClass series; or Vicon VAX series Proximity cards or equal with photo printing capability.

2.4 PUSH-BUTTON SWITCHES

- A. Securitron Magnalock by Assa Abloy; Honeywell/Ademco 270R or equal.
- B. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless-steel switch enclosures.
- C. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
- D. Enclosures shall additionally be suitable for installation in the following locations:
 - 1. Indoors, controlled environment.
- E. Power: Push-button switches shall be powered from their associated controller, using dc control.

2.5 CABLES

- A. General Cable Requirements: Comply with requirements in Section 270513 "Conductors and Cables for Communications Systems" and as recommended by system manufacturer for integration requirement.
- B. PVC-Jacketed, TIA 232-F.
 - 1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Polypropylene insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.
- C. PVC-Jacketed, TIA 485-A Cables:
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. NFPA 70 Type: Type CM.
 - 6. Flame Resistance: Comply with UL 1581.

D. Multiconductor, PVC, Reader and Wiegand Keypad Cables:

1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.
4. For TIA 232-F applications.

E. LAN Cabling:

1. Category 6 or higher.

2.6 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

2.7 SYSTEM CONTROL PANELS

Basis of Design: Vicon VAX-MDK-8 or equal, multi-door controller. Provide input / output controller modules, quantity as required for total number of controlled doors plus two spare door control modules for future doors.

1. Eight Door Kit mounted in steel vented and lockable enclosure.
2. 8 x lock power output 12VDC 500mA
3. 16 x configurable Solid State Relay 24VDC 1A
4. 8 x Wiegand reader inputs
5. 24 x dry contact configurable inputs

B. Features:

1. Supports up to 8 Readers (1 for each door)
2. Storage:
 - a. Up to 100,000 users/cardholders per controller.
 - b. 50,000 event storage onboard
3. Lock Power:
 - a. Up to 8 x Solid State Wet Relay 12VDC @ 500mA
 - b. LED Indicator: Up to 8 X Lock Power LED
4. Relay Outputs:
 - a. Up to 16 X Solid State Relay 60V (TVS circuit limits 24V), 1A.
 - b. Fully configurable, no mechanical parts.
 - c. Dry Contact.
 - d. LED Indicator: Up to 8 x output indicator
5. Input Functions include:
 - a. Request to exit
 - b. Door contact
 - c. Door opener to enter (require card)

- d. Door opener to exit
- e. External motion sensor
- f. Emergency alarm
- g. External alarm status (check if alarm system is armed)
- h. Door prevent unlock (used with mantraps)

2.8 PHOTOBADGING PRINTER AND CARD ENCODER

- A. Provide photobadging printer similar to HID Fargo DTC4250e or equal photo badging printer.
 - 1. Install and configure printer to function with credentialing software.
 - 2. Include CardPresso or equal card production and management software.
 - 3.

2.9 CREDENTIALING SOFTWARE

- A. Provide, install and configure credentialing software on client computer or access control server. Basis of Design: EasyLobby, CardPresso, Swift ID or equal.

2.10 ACCESS CONTROL SERVER

- A. Provide and configure Rack-mounted access control server in TR218 including all connectivity to the access control system.
- B. Minimum PC Specifications
 - 1. Microsoft Windows 10, 64bit.
 - 2. 4GB RAM
 - 3. 250GB minimum, SSD, Solid State Drive.
 - 4. 100/1000 BaseT Ethernet interface
- C. Software
 - 1. Vicon Access Control Server VAX-PC-A-RK or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Section 270513 "Conductors and Cables for Communications Systems."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.
- F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

- A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. between terminations.
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
- E. Card Readers and Keypads:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. between terminations.
- G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. between terminations.

3.5 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Bond shields and drain conductors to ground at only one point in each circuit.
- D. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

- A. Install card readers and pushbuttons.

3.7 IDENTIFICATION

- A. Comply with applicable requirements in TIA 606-B - Identification for Communications Systems.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.

2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. Provide three, 2- hour training sessions, minimum. Provide video recording of one session for client use.

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

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SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Nonsystem smoke detectors.
 - 5. Heat detectors.
 - 6. Notification appliances.
 - 7. Remote annunciator.
 - 8. Addressable interface device.
 - 9. Radio alarm transmitter.

1.2 DEFINITIONS

- A. FACP: Fire Alarm Control Panel.
- B. NICET: National Institute for Certification in Engineering Technologies.
- C. PC: Personal computer.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Detail assembly and support requirements.

5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
 - d. Show air-sampling detector pipe routing.
13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device.

C. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level II minimum.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

- a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
- c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
- d. Riser diagram.
- e. Device addresses.
- f. Record copy of site-specific software.
- g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
- h. Manufacturer's required maintenance related to system warranty requirements.
- i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. ADDITIONAL INSTALLED DEVICES

1. Electrical Contractor shall include in his bid an allowance for the installation of the following:
 - a. Smoke detectors Twenty
 - b. Duct smoke detectors One
 - c. Manual fire alarm box Three
 - d. Audible device Two
 - e. Combination audible/visual device Ten
 - f. Addressable interface device Ten
2. The contractor shall include 50'-0" length of conduit and wire for each device, and shall assume that the devices will be installed at the completion of the project as directed by the Architect or Engineer. If not all devices are used, the remaining devices shall be turned over to the Owner. The unused amount of labor, conduit and wire shall be credited to the Owner in a deduct change order.

1.7 QUALITY ASSURANCE

- A. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **FIVE** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice /strobe evacuation.
- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided shall be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire Alarm Signal:
1. Fire Alarm signal initiation shall be by one or more of the following devices and/or systems:
 - a. Manual stations.
 - b. Heat detectors.
 - c. Smoke detectors.
 - d. Duct smoke detectors.
 - e. Carbon monoxide detectors.
 - f. Automatic sprinkler system water flow.
 - g. Fire standpipe system.
 - h. Dry system pressure flow switch.
 - i. Fire pump running.
 2. Fire-alarm signal shall initiate the following actions:
 - a. Continuously operate alarm notification appliances, including voice evacuation notices.
 - b. Identify alarm and specific initiating device at fire-alarm control units and remote annunciators.
 - c. Identify alarm and specific initiating device at connected network control panels and/or off-premises network control panels.
 - d. Transmit an alarm signal to the remote alarm receiving station.
 - e. Unlock electric door locks in designated egress paths.

- f. Recall elevators to primary or alternate recall floors.
- g. Activate emergency lighting control.
- h. Activate emergency shutoffs for gas and fuel supplies.
- i. Record events in the system memory.
- j. Shutdown air handling units.

B. Supervisory Signal:

1. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - a. Valve supervisory switch.
 - b. High- or low-air-pressure switch of a dry-pipe sprinkler system.
 - c. Fire pump running.
 - d. Fire-pump loss of power.
 - e. Fire-pump power phase reversal.
 - f. User disabling of zones or individual devices.
 - g. Loss of communication with any panel on the network.
 - h. Generator running
 - i. Generator abnormal condition (e.g. failure to start, temperature alarms, low fluids, etc.)
2. System Supervisory signal shall initiate the following actions:
 - a. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
 - b. Record the event on system printer.
 - c. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
 - d. Transmit system status to building management system.
 - e. Display system status on graphic annunciator.

C. System Trouble Signal:

1. System trouble signal initiation shall be by one or more of the following devices and actions:
 - a. Open circuits, shorts, and grounds in designated circuits.
 - b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - c. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - d. Loss of primary power at fire-alarm control unit.
 - e. Ground or a single break in internal circuits of fire-alarm control unit.
 - f. Abnormal ac voltage at fire-alarm control unit.
 - g. Break in standby battery circuitry.
 - h. Failure of battery charging.
 - i. Abnormal position of any switch at fire-alarm control unit or annunciator.
 - j. Voice signal amplifier failure.
2. System trouble signal shall initiate the following actions:

- a. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
- b. Transmit system status to building management system.

2.3 FIRE-ALARM CONTROL UNIT

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

1. Fire-Lite Alarms.
2. GAMEWELL.
3. GE UTC Fire & Security; A United Technologies Company.
4. Notifier.
5. Siemens Industry, Inc.; Fire Safety Division.
6. Silent Knight.
7. SimplexGrinnell LP.
8. EST Edwards

- B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. The FACP shall be listed for use with supervisory signals from other essential building systems.
 - f. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Shall indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Contractor shall verify quantity of each circuit type required with his approved equipment vendor prior to bidding. Fire alarm riser drawings that may be shown on the drawings are intended to be schematic in nature and may not depict all circuits where multiple circuits are required.
2. Pathway Class Designations: NFPA 72, Class B.
3. Pathway Survivability: Level 1.
4. Install no more than 100 addressable devices on each signaling-line circuit.
5. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station remote station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One USB RS 232 port for PC configuration.
 - d. One RS 232 port for voice evacuation interface.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Sound general alarm if the alarm is verified.
4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.

- L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed, valve-regulated, recombinant lead acid.
- M. Surge Suppression: Provide surge suppression devices at each 120V circuit serving fire alarm equipment. Refer to specification section 26 43 13 – Surge Protection for Low Voltage Electrical Power for requirements.
- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- O. At main fire alarm control panel and lobby remote annunciator panel, provide programmed soft key to initiate fire fighters stairwell door release. Initiation of door release sequence shall signal fire alarm relay modules located at each stairwell electrified door to fail safe. Soft key shall be concealed behind secured panel cover and shall be labeled.

2.4 REMOTE FIRE ALARM DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:
 - 1. Cooper Wheelock.
 - 2. Fire-Lite Alarms.
 - 3. GAMEWELL.
 - 4. GE UTC Fire & Security; A United Technologies Company.
 - 5. Notifier.
 - 6. Siemens Industry, Inc.; Fire Safety Division.
 - 7. Silent Knight.
 - 8. SimplexGrinnell LP.
 - 9. System Sensor.
- B. Manual Fire-Alarm Boxes
 - 1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - a. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - b. Station Reset: Key- or wrench-operated switch.

C. Notification Appliances

1. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
2. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - a. Rated Light Output minimum:
 - 1) 15 cd. in corridors and transition spaces, unless otherwise noted.
 - 2) 30 cd. in other spaces, unless otherwise noted.
 - b. Mounting: Wall mounted unless otherwise indicated.
 - c. Flashing shall be in a temporal pattern, synchronized with other units.
 - d. Strobe Leads: Factory connected to screw terminals.
 - e. Mounting Faceplate: Factory finished, RED.
3. Voice/Tone Notification Appliances:
 - a. Comply with UL 1480.
 - b. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - c. High-Range Units: Rated 2 to 15 W.
 - d. Low-Range Units: Rated 1 to 2 W.
 - e. Mounting: Flush semirecessed or surface mounted and bidirectional.
 - f. Matching Transformers: Tap range matched to acoustical environment of speaker location.
 - g. Mounting Faceplate: Factory finished, RED.

D. Addressable Interface Device

1. General:
 - a. Include address-setting means on the module.
 - b. Store an internal identifying code for control panel use to identify the module type.
 - c. Listed for controlling HVAC fan motor controllers.
2. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
3. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown .
 - a. Allow the control panel to switch the relay contacts on command.
 - b. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Control Module:
 - a. Operate notification devices.

- b. Operate solenoids for use in sprinkler service.

E. System Smoke Detectors

1. General Requirements for System Smoke Detectors:
 - a. Comply with UL 268; operating at 24-V dc, nominal.
 - b. Detectors shall be two-wire type.
 - c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - e. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 1) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - 2) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - 3) Multiple levels of detection sensitivity for each sensor.
 - 4) Sensitivity levels based on time of day.
2. Photoelectric Smoke Detectors:
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
3. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - c. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - d. Each sensor shall have multiple levels of detection sensitivity.

- e. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- f. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

F. Carbon Monoxide Detectors

- 1. General: Carbon monoxide detector listed for connection to fire-alarm system.
 - a. Mounting: Adapter plate for outlet box mounting.
 - b. Testable by introducing test carbon monoxide into the sensing cell.
 - c. Detector shall provide alarm contacts and trouble contacts.
 - d. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - e. Comply with UL 2075.
 - f. Locate, mount, and wire according to manufacturer's written instructions.
 - g. Provide means for addressable connection to fire-alarm system.
 - h. Test button simulates an alarm condition.

G. Multicriteria Detectors

- 1. Mounting: Adapter plate for outlet box mounting Twist-lock base interchangeable with smoke-detector bases.
- 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- 3. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.
- 4. Test button tests all sensors in the detector.
- 5. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present sensitivity selected.
 - d. Sensor range (normal, dirty, etc.).
- 6. Sensors: The detector shall be comprised of Three sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor.
 - a. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
 - b. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
 - c. Each sensor shall be separately listed according to requirements for its detector type.

H. Residential Unit Smoke Detectors

- 1. Provide multi-criteria smoke sensors with sounder bases to meet the following:
 - a. Photoelectric type sensor and carbon monoxide sensor.

- b. Sounder Base, 520Hz: Provide minimum audible alarm of 85 dBA at 10 feet; minimum of 75 dBA “at the pillow”.
 - c. Activation of room smoke sensor to immediately and automatically sound an alarm within the room of incident.
 2. System smoke sensor normal and emergency power is provided by the Fire Alarm Control Panel (FACP).
 3. In units or other mixed Sleeping / Living Units, provide smoke sensors in each separate sleeping / living rooms (or in areas providing access to the corridor doorway). Multiple sensor sounder bases located within the same suite or unit shall sound at the same time.
- I. Residential Unit Smoke Alarms (Handicap Accessible and Hearing Impaired): Same as above with the following additions.
 - a. Visible Alarm Device: Xenon Strobe. Activation of detector to cause both alarm horn and visible alarm device (xenon strobe) to flash.
- J. Heat Detectors
 1. General Requirements for Heat Detectors: Comply with UL 521.
 - a. Temperature sensors shall test for and communicate the sensitivity range of the device.
 2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - a. Mounting: Adapter plate for outlet box mounting Twist-lock base interchangeable with smoke-detector bases.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- K. Remote Annunciator
 1. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - a. Mounting: Flush cabinet, NEMA 250, Type 1.
 2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.5 RADIO ALARM TRANSMITTER

- A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.

- B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.
1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 3. Normal Power Input: 120-V ac.
 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 7. Antenna-Cable Connectors: Weatherproof.
 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 6. Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm .

2.6 FIRE ALARM CABLE

- A. Furnish only wire recommended by the fire alarm system manufacturer. Coordinate closely with equipment vendor for quantity, type, and size of fire alarm cables required.
- B. SLC Circuit Cable for Addressable Initiation Devices: Power-limited (FPLP) solid or stranded (7 strand minimum) copper, 75 Degrees C insulation, #18 AWG twisted, shielded or unshielded, color-coded vinyl insulation, PVC jacket.
- C. NAC Circuit Cable for Notification Devices: Power-limited (FPLP), solid or stranded (7 strand minimum) copper, 75 Degrees C insulation, #14 AWG twisted, shielded or unshielded, color-coded vinyl insulation, PVC jacket.
- D. All wiring shall be color coded and labeled at each end. Splicing by way of wire nuts is prohibited.
- E. All fire alarm wiring shall be plenum rated where located in air plenum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- K. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists **100-mph** wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

- A. Fire alarm cable above ceilings and in non-accessible locations may be routed exposed, where supported by j-hooks or other approved method.
 - 1. Exposed fire alarm cable located less than 96 inches above the floor shall be installed in raceway.
- B. Exposed fire alarm raceways shall be painted red enamel.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Magnetically held-open doors.
 - 2. Electronically locked doors and access gates.
 - 3. Alarm-initiating connection to elevator recall system and components.
 - 4. Alarm-initiating connection to activate emergency lighting control.
 - 5. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 6. Supervisory connections at valve supervisory switches.
 - 7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 8. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 - 9. Supervisory connections at fire-pump engine control panel.
 - 10. Supervisory connections at generator.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Engineer and authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections :
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include TWELVE months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for TWO years.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

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SECTION 28 31 16

RESCUE ASSISTANCE SIGNAL SYSTEM - AUDIO/VISUAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Furnish, install, and wire all equipment associated with the installation of an Audio-Visual Rescue Assistance Signal System to comply with ADA requirements. This work shall include a main annunciator panel, remote call stations, power supply, outlet boxes, cables and wiring as shown on the drawings and as specified herein.

1.2 SUBMITTALS

- A. General: Data sheets on all equipment being provided as well recommended cable types. Internal control cabinet drawings showing internal block diagram connections shall be provided. Wiring diagrams showing typical field wiring connections as well as single line floor plan indicating equipment locations as well as cable routings and quantities.
- B. Project Closeout
 1. A one-year maintenance contract offering continued factory authorized service of this system shall be provided as part of this contract. Built drawings that include changes to wiring, wiring designations, junction box labeling and other pertinent information shall be supplied upon completion of the project.
 2. The contractor shall furnish manufacturer's manuals of the completed system including individual specifications sheets, schematics, inter-panel and intra-panel wiring diagrams.
 - a. All information necessary for the proper maintenance and operation of the system must be included.
 3. As built drawings that include changes to wiring, wiring designations, junction box labeling, and other pertinent information shall be supplied upon completion of the project.
 4. Provide a minimum of two (2) hours of in-service training with the system.
 - a. These sessions shall be broken into segments that will facilitate the training of the system users in operating station equipment.
 - b. Operating manuals and user's guides shall be provided at the time of training.

1.3 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

- B. **Manufacturer's Warranty:** Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
 - 1. Warranty Period: 1 year commencing on the Date of Substantial Completion.
 - 2. All materials and installation shall be guaranteed to be free of defects in material and workmanship for one year after final acceptance of installation and tests.

1.4 INSTALLATION STANDARDS

- A. The system shall be installed in accordance with the 2017 NEC and ADA requirements.
- B. The completed system shall be in compliance with state and local electrical codes.
- C. All wiring shall test free from grounds and shorts.

1.5 SYSTEM OPERATIONS

- A. Furnish, install and place into operation a Rescue Assistance System for this building as indicated on the drawings and as specified herein.
- B. A common annunciator shall be provided at the main building entrance where shown on the drawings to indicate light and tone signals from multiple remote call stations.
 - 1. When the call station switch is activated, a red LED button illuminates and a one shot tone sounds.
 - 2. When the alarm signal is acknowledged, the remote call station is signaled with a flashing light and tone.
 - 3. Voice communication with the remote call can then be initiated from the annunciator.
 - 4. Optional access to a public telephone system shall be provided when specified.

PART 2 - PRODUCTS (RESCUE ASSISTANCE SYSTEM - AUDIO/VISUAL)

2.1 RESCUE ASSISTANCE-VISUAL EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cornell Communications Inc
 - 2. Rath Communications
 - 3. Alpha Communications

2.2 SYSTEM DESCRIPTION

- A. Equipment

1. This system shall consist of multiple remote call stations, which will share a common annunciator panel and access to a public telephone system for external alarm notification.

B. Annunciator

1. The annunciator panel shall be capable of supporting 12 call stations.
 - a. Verify location with the Local Fire Marshal and the Owner.
2. An alternate action switch with internal LED indicator shall be included for each zone.
 - a. A yellow LED light on the zone switch shall illuminate and the alarm shall emit a repeating sound if the supervised wiring is faulted.
3. An audible alarm shall be mounted on the annunciator panel, which will emit a minimum sound level of 90 db at 30 cm when a remote station calls.
 - a. Depressing the zone switch will answer a zone and open the intercom line to the zone.
4. The front panel shall have silk-screened zone designations and operating directions as well as zone designation strips.
5. The power supply shall be a 120 volt emergency battery backup.
6. Annunciator panel shall monitor all system cabling for integrity and initiate trouble alarm to signal errors.

C. Remote Call Stations

1. The remote call station shall be vandal resistant with one momentary switch with LED and loudspeaker.
2. The station shall have hands free voice communication with the annunciator.
3. The station shall have silk-screened operating instructions.
4. The station shall be flush wall mounted on a 2-gang stainless steel plate with a 48" maximum mounting height for forward reach, and a 54" maximum for side reach.

2.3 SOURCE QUALITY

- A. Source Quality: Obtain rescue assistance equipment and system from a single manufacturer.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.

3.2 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

3.3 INSTALLATION

- A. Cabling Requirements
 - 1. Verify cable types with the Rescue Assistance System Manufacturer.
- B. Rescue Assistance Signal System - Audio/Visual Installation
 - 1. Complete system shall be installed in accordance with manufacturer's recommendations.
 - 2. Wiring shall be installed in raceways throughout the building. a. Conduit shall be 3/4" minimum.

3.4 FIELD QUALITY REQUIREMENTS

- A. Site Tests (Post Installation Testing): Checkout final connections to the system shall be made by a factory technician authorized by the manufacturer of the products installed.
 - 1. Factory authorized technicians shall demonstrate operation of the complete system and each major component to the staff.
 - 2. System field wiring diagrams shall be provided to this subcontractor by the system prior to installation.
- B. Inspection: Perform a complete functional test of the system upon completion of the installation and instruct the staff in the operation and maintenance of the system.

3.5 CLEANING

- A. Cleaning: Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Remove construction debris from project site and legally dispose of debris.

END OF SECTION 28 31 16

SECTION 28 53 19

EMERGENCY RESPONDERS RADIO SYSTEM (ERRS)

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification describes the technical and performance criteria for deploying a Neutral-Host Basic EMERGENCY RESPONDERS RADIO SYSTEM (ERRS), also known as a DISTRIBUTED ANTENNA SYSTEM (ERRS) capable of supporting Public Safety Networks (PSN).
- B. This system will be required when over-the-air radio coverage does not meet the requirements outlined in the OBC and NFPA. The building shall be tested at the time of substantial completion using spectrum analysis to determine if the ERRS system is required. Testing shall be performed by certified personnel. The AHJ shall require the ERRS system if more than 5% of the tested floor area is over a -95db signal threshold.

1.2 SECTION INCLUDES

- A. This specification describes technical and performance criteria for deploying a Neutral-Host emergency responders radio system (ERRS) capable of supporting Public Safety Networks (PSN). The ERRS components specified in this document include: Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners, Couplers, Fiber-Optic Cable, Fiber-Optic Connectors, and Fiber-Optic Jumpers, Bi-Directional Amplifiers (BDA), Fiber-Optic Master Unit and Fiber-Optic Remote Units.

1.3 SYSTEM DESCRIPTION

- A. Services: Upon commissioning, the ERRS shall provide coverage for the PSNs on all frequencies currently being used by the designated PSN in the given market.
- B. PSN Approval: The Contractor shall propose and deploy a ERRS system capable of receiving approval of the PSN Authority Having Jurisdiction (AHJ).
- C. Broadband Active Distribution: Single-mode fiber-optic cable will be used for Active distribution. In-line amplifiers are not allowed.
- D. Network Management:
 - 1. NMS: The ERRS shall have a Network Management System (NMS) capable of alarm, monitor, configuration and control of all Active Components.
 - 2. SNMP Integration: The ERRS NMS shall be capable of integration with 3rd party SNMP based NMS products for alarm purposes and provide alarming information.

1.4 ALTERNATIVES

- A. No alternative component(s) shall be accepted as equal to the components and manufacturers specified in this document unless the Contractor proves that the alternative component(s) are of equal or superior specifications and quality, and that they have been used in similar projects of size and complexity for no less than 3-years. The following information shall be required for each alternative component with submittal of the bid response:
1. Passive Components:
 - a. Product samples
 - b. Detailed product specifications
 - c. Independent test results verifying the product specifications
 - d. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for new purchase for a period of 7-years from the date of system acceptance.
 2. Active Components:
 - a. Hardware and software manuals
 - b. Detailed product specifications
 - c. Mean Time Between Failure (MTBF) data for each Active Component
 - d. Independent test results verifying the product specifications
 - e. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall be supported for a period of 7-years from the date of system acceptance.
 - f. For Active Components serving the WSPs, written documentation from the WSPs that the alternative component(s) are approved for use within the WSP's network and that interconnection of the ERRS to the WSP's network will not be withheld due to the alternative component being used in the ERRS.
 - g. For Active Components serving the PSN, written documentation from the AHJ that the alternative component(s) are approved for use within the PSN and that system acceptance of the ERRS to the PSN will not be withheld due to the alternative component being used in the ERRS.

1.5 CODES, STANDARDS AND CERTIFICATIONS

- A. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent requirements.
- B. Requirements set forth by first-responder code, ordinance, or the PSN AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the ERRS complies with local code, ordinances or requirements established by the PSN AHJ.

1.6 ABBREVIATIONS AND ACRONYMS

- A. ACG: Automatic Gain Control
- B. AHJ: Authority Having Jurisdiction
- C. ATP: Acceptance Test Plan
- D. AWS: Advanced Wireless Service
- E. BDA: Bi-Direction Amplifier
- F. BOM: Bill of Materials
- G. BRS: Broadband Radio Service
- H. BTS: Base Transceiver Station
- I. CDMA: Code Division Multiple Access
- J. C/N: Carrier-to-Noise Ratio
- K. CWDM: Coarse Wave Division Multiplexing
- L. ERRS: Distributed Antenna System
- M. DWDM: Dense Wave Division Multiplexing
- N. EBS: Educational Broadband Service
- O. ESMR: Enhanced Specialized Mobile Radio
- P. FCC: Federal Communications Commission
- Q. GUI: Graphical User Interface
- R. iDEN: Integrated Enhanced Digital Network
- S. LMR: Land Mobile Radio
- T. LTE: Long Term Evolution
- U. MTBF: Mean Time Between Failure
- V. NFPA: National Fire Protection Association
- W. NMS: Network Management System
- X. PCS: Personal Communications System
- Y. PSN: Public Safety Network
- Z. RoF: Radio-over-Fiber

- AA. RoHS: Restriction of Hazardous Substances
- BB. RSL: Received Signal Level
- CC. SISO: Single-Input, Single-Output
- DD. SMR: Specialized Mobile Radio
- EE. SMS: Short Message Service
- FF. SNIR: Signal-to-Noise Interference Ratio
- GG. SNMP: Simple Network Management Protocol
- HH. SOW: Statement of Work
- II. VSWR: Voltage Standing Wave Ratio
- JJ. WSP: Wireless Service Provider

1.7 DEFINITIONS

- A. Acceptance: Expressed approval by the customer
- B. Active: ERRS components that require AC/DC power for operation
- C. Carrier Approval: Expressed approval to interconnect to the WSP macro network
- D. Channel: A path for an RF transmission between two points
- E. Component: A main system element of the ERRS
- F. Contractor: The prime contractor bidding the project
- G. Passive: ERRS components that do not require AC/DC power for operation

1.8 PERFORMANCE REQUIREMENTS

- A. PSN ERRS:
 - 1. The PSN ERRS shall comply with NFPA-1 2012 Edition.
 - 2. Where the in-building coverage requirements include 700 - 800 MHz public safety system and commercial wireless in-building coverage, the two systems shall operate over a unified Passive Cable and Coverage Antenna Infrastructure.
 - 3. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above in Section 1.04 A. with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.

4. The ERRS shall be capable of upgrade, without additional hardware or software, to allow for changes to system frequencies within the deployed frequency band in order to maintain radio system coverage as originally designed.
5. The contractor shall explain the method used to avoid downlink and uplink interference.

1.9 ADDITIONAL REQUIREMENTS

- A. PSN Approval: When approval of the ERRS deployment is required by code or ordinance, the Contractor shall be responsible for facilitating the AHJ approval(s) per the requirements of the code or ordinance.

1.10 SUBMITTALS

- A. Submittal Requirements with Bid Response:
 1. Product Data: Submit manufacturer datasheets for the following components:
 - a. Donor and Coverage Antennas
 - b. Coaxial Cable and Connectors
 - c. Splitters, Combiners and Couplers
 - d. Bi-Directional Amplifiers (BDA)
 - e. Fiber-Optic Master Unit
 - f. Fiber-Optic Remote Units
 2. Shop Drawings: Submit the following items:
 - a. RF Link Budget
 - b. Overlay of System Components on Floor Plans
 - c. Drawings for Donor Antenna and Grounding
 - d. Bill of Materials (BOM)
 3. Statement of Work (SOW): Submit sample SOW
 4. Acceptance Test Plan (ATP): Submit sample ATP
 5. Recommended Spares
 6. Warranty Documents:
 - a. Submit for all manufactured Components specified in this Section.
 - b. Submit Contractor's System Warranty.
 - c. Submit Manufacturer's Extended Warranty.
- B. Submittal Requirements Prior to Start of Construction
 1. Final RF link budget
 2. Overlay of system Components on floor plans
 3. Drawings for Donor Antenna and grounding
 4. RF propagation modeling
 5. Signal to Noise Interference Ratio (SNIR) Map
 6. Bill of Materials (BOM)
 7. Maintenance Service Contract
 8. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
 9. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.
- C. Submittal Requirements at Close Out

1. Drawings: Submit as-built drawings indicating:
 - a. Donor antenna, grounding and lighting protection details
 - b. Cable routing, splitters, couplers and coverage antenna locations
 - c. Active component locations, layout and configuration
2. Test Reports
 - a. PSN: Submit Accepted ATP reports confirming the requirements of Section 1.07 B have been met.
3. Field Reports: Submit sweep-testing results for all cable runs.
4. Field Reports: Submit OTDR test results for all fiber runs.
5. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
6. Warranty Documents:
 - a. Submit for all manufactured components specified in this Section.
 - b. Submit Contractor's System Warranty.
 - c. Submit Manufacturer's Extended Warranty

1.11 QUALITY ASSURANCE

- A. Qualifications: Contractor, and/or Sub-Contractors, shall have a minimum of 5-years full-time experience executing work of similar scope and complexity.
- B. Certifications:
 1. Passive Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.
 2. Active Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.

1.12 WARRANTY

- A. Manufacturer Warranty:
 1. Splitters, Couplers and Coverage Antennas: 5-year limited warranty from date of system acceptance.
 2. Coaxial Cable and Connectors: 10-year limited warranty from date of system acceptance.
 3. Fiber-Optic Cable: 20-year limited warranty from date of system acceptance.
 4. Active Components: The earliest of 1-year limited warranty from date of system installation or 15 months from date of shipment.
- B. Contractor Warranty: Contractor shall warrant the system performance for 1-year.
- C. Manufacturers Extended Warranty:
 1. The ERRS shall be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified contractor. The certification program covers a certified system defined as a ERRS installation performed by a certified contractor using components conforming to section 2.01 following all the manufactures recommendations, installation instructions and best practices.

Manufacturer shall administer a follow-on program through the contractor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support current and future modulation formats in the frequency bands for which it is designed, during the 20-year warranty of the certified system.

2. The second portion of the certification is a 20-year warranty provided by the manufacturer and the contractor on all cable products within the system (fiber-optic cable, coaxial riser cable, plenum coaxial cable and associated connectors, etc.). In conflict with 1.13 A 3 where we say the fiber has a 20 year warranty
3. In the event that the certified system ceases to support the certified application(s), whether at the time of ATP, during normal use or when upgrading to additional frequency bands, the manufacturer and Contractor shall commit to promptly implement corrective action.
4. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the products used in the ERRS.

1.13 MAINTENANCE

- A. The Contractor shall provide an optional maintenance service contract, covering for a period of one-year: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specified Manufacturer: Zinwave
- B. Acceptable Manufacturers: CommScope, Honeywell.

2.2 COMPONENTS

- A. 700 MHz LMR Yagi Donor Antennas:
 1. Electrical:
 - a. Frequency band, 746 - 806 MHz
 - b. VSWR \leq 1.5:1
 - c. Gain: \geq 11.1 dBi
 - d. Maximum input power: 100 watts
 - e. Polarization: Vertical
 - f. Front-to-back ratio: \geq 15 dB
 - g. Impedance: 50 Ω
 - h. Beamwidth, Horizontal, degrees: 60
 - i. Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this Section.
 2. Mechanical:
 - a. Connector: 50 Ω N Type Female
 - b. Mounting: Pole

3. Environmental:
 - a. Temperature: -40 °C to +60 °C
 - b. Lighting protection: Direct ground to Lightning Protcn. System.
 - c. Waterproof level: IP 66
 - d. Wind Speed, maximum: 125 mph
 4. Approved Manufacturer: Andrew DB498-PS or equivalent in accordance with
 5. Section 1.05.
- B. Omni-Directional Coverage: Omni-Directional Coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
1. Electrical Band 1:
 - a. Frequency Band: 698 – 800 MHz
 - b. VSWR: $\leq 1.8:1$
 - c. Gain: ≥ 1.5 dBi
 - d. Maximum input power:
 - e. Impedance: 50 Ω
 - f. Beamwidth, Horizontal: 360° omnidirectional
 - g. Beamwidth, Vertical: 80° nominal
 - h. Return Loss: 10.9 dB
 2. Electrical Band 2:
 - a. Frequency Band: 1710 – 2700 MHz and 800 – 960 MHz
 - b. VSWR: $\leq 1.5:1$
 - c. Gain: ≥ 1.5 dBi @ 800–960 MHz and ≥ 5.0 dBi @ 1710 – 2700 MHz
 - d. Maximum input power:
 - e. Impedance: 50 Ω
 - f. Beamwidth, Horizontal: 360° omnidirectional
 - g. Beamwidth, Vertical: 65° nominal
 - h. Return Loss: ≤ 13.9 dB
 3. Mechanical:
 - a. Connector: 50 Ω N Type Female
 - b. Mounting: Thru-hole ceiling mount
 - c. Radome material: ABS, UV resistant
 - d. Pigtail cable: KSR195, plenum rated
 4. Environmental:
 - a. Application: Indoor
 - b. Operating Temperature: 40 °C to +60 °C (40 °F to +140 °F)
 - c. Relative Humidity: Up to 100%
 5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
 6. Approved Manufacturer: Andrew CELLMAX-O-CPUSE or equivalent, in accordance with Section 1.05.
- C. Directional Coverage Antennas: Directional coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
1. Electrical Band 1:
 - a. Frequency Band: 698 – 800 MHz
 - b. VSWR: $\leq 1.8:1$
 - c. Gain: ≥ 5.0 dBi @ 698 – 800 MHz
 - d. Maximum input power: 50W
 - e. Impedance: 50 Ω
 - f. Beamwidth, Horizontal: 110° nominal
 - g. Polarization: Vertical

E. Fiber-Optic Pigtails:

1. General Specifications:

- a. To maintain channel integrity, optical fiber patch cords and pigtails shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots, and shall have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtails shall be available with the following options as specified or indicated:
 - 1) Termination types: SC-APC
 - 2) Connector/cable configuration: Simplex and duplex
 - 3) Fire ratings: Riser, plenum and/or LSZH
 - 4) Patch cord outside diameters: 1.6 millimeters (0.063 inches) and 3.0 millimeters (0.118 inches)
 - 5) Pigtails: Ruggedized and tight-buffered optical fiber—0.9 millimeters (0.035 inches) outside diameter
 - 7) Lengths: As specified or indicated
 - 8) Approved Manufacturer: CommScope RFT-01RF09-8W-SCA-XX, single reinforced buffered 900 μm, LightScope ZWP single-mode fiber, angled polished connector or equivalent, in accordance with Section 1.05.

F. Air Dielectric, Plenum Rated Cable:

1. Material Characteristics:

- a. Jacket: Halogenated, Fire-Retardant
- b. Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
- c. Inner Conductor Material: Copper-Clad Aluminum Wire

2. Electrical Characteristics:

- a. Impedance: $50 \pm 2.0 \Omega$
- b. Frequency Band: 1 - 8800 MHz
- c. Peak Power Rating: $\geq 40.0 \text{ kW}$

3. Mechanical Characteristics:

- a. Diameter Over Jacket: $\leq .627 \text{ in}$
- b. Minimum Bending Radius: $\leq 5 \text{ in}$
- c. One Time Minimum Bending Radius: $\leq 3 \text{ in}$

4. Attenuation Characteristics:

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.848
450	≤ 1.53
800	≤ 2.105
2000	≤ 3.564
Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)	

- 5. Approved Manufacturer: Andrew HL4RP-50A, AL4RPV-50A or equivalent, in accordance with Section 1.05.

G. Foam Dielectric Cable:

1. Material Characteristics:

- a. Jacket: Non-halogenated, Fire-Retardant Ployolefin

- b. Outer Conductor Material: Corrugated Copper
- c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
- 2. Electrical Characteristics:
 - a. Impedance: $50 \pm 1.0 \Omega$
 - b. Frequency Band: 1/2" Nominal: 1 - 8800 MHz, 7/8" Nominal: 1 - 5000 MHz
 - c. Peak Power Rating: $\geq 40.0 \text{ kW}$
- 3. Mechanical Characteristics:
 - a. Diameter Over Jacket: 1/2" Nominal: $\leq .630 \text{ in}$, 7/8" Nominal: $\leq 1.1 \text{ in}$
 - b. Minimum Bending Radius: 1/2" Nominal: $\leq 5 \text{ in}$, 7/8" Nominal: $\leq 10 \text{ in}$
 - c. One Time Minimum Bending Radius: 1/2" Nominal: $\leq 2 \text{ in}$, 7/8" Nominal: $\leq 5 \text{ in}$
- 4. Attenuation Characteristics: 1/2" Nominal

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.815
450	≤ 1.447
800	≤ 1.968
2000	≤ 3.251
Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)	

- 5. Attenuation Characteristics: 7/8" Nominal:

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.417
450	$\leq .744$
800	≤ 1.014
2000	≤ 1.683
Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)	

- 6. Approved Manufacturer: Andrew LDF4-50A, FXL-540-NHR, FXL-780-NHR or equivalent, in accordance with Section 1.03.

H. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:

- 1. Approved Manufacturer: Andrew or equivalent, in accordance with Section 1.03.

I. BDA:

- 1. When the AHJ and/or WSP dictates a BDA drive the ERRS, the BDA shall be of modular design and use digital filtering to mitigate interference and accommodate multiple services for PSNs and WSPs.
- 2. Characteristics
 - a. Operating Temperature Range: $-33 \text{ }^\circ\text{C}$ to $+50 \text{ }^\circ\text{C}$
 - b. Chassis: Shall be of modular design with ≥ 4 frequency bands per 19" chassis.
 - c. Chassis shall not exceed four Rack Units (RUs) in height. Filtering: Digital
 - d. Separate Control: Each RF amplifier shall be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.

- e. FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ESMR frequency bands
 - f. Alarming: Shall support both SNMP and SMS using wireless modem
 - g. Mounting Options: shall support rack, wall and pole mounting
 - h. Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806- 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS
3. Compliance:
- a. NFPA: The BDA shall comply with NFPA-1 2009 edition Annex O In-Building Public Safety Radio Enhancement Systems.
 - b. FCC: Shall be FCC type certified.
4. Approved Manufacturer: Andrew Node A or equivalent, in accordance with Section 1.03.
- J. Fiber-Optic Master Unit: When building size dictates an Active fiber ERRS, the Fiber-Optic Master Unit shall convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber-Optic Remote Units.
1. Characteristics
- a. Transmission Media: Single-mode fiber at 1310 nm
 - b. Operating Temperature Range: +5 °C to +40 °C
 - c. Impedance: 50 Ω
 - d. Chassis:
 - 1) Shall be of modular design capable of supporting ≥ 32 Remote Units per 19", 4 RU chassis
 - 2) Shall support redundant power supplies
 - 3) Shall have the capability to remotely power the Remote Units via composite fiber-optic cable
 - e. Automatic Gain Control (AGC): Shall provide AGC for optical loss compensation
 - f. Optical Budget: Shall support ≤ 3 dB optical budget (~3 km or 2 miles)
 - g. Auxiliary Channel: Shall provide an input to support 400 to 2700 MHz for future expandability
 - h. Interlink: Shall support one fiber or two fibers bi-directional optical link for distances up to 20 km with a 10 dB optical budget
 - i. Remote Supervision:
 - 1) Shall support the TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers
 - 2) Remote access shall be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems
 - 3) Each Active device shall be manageable via a Web GUI
 - 4) Auto Mapping: Each board position shall be automatically mapped during system turn-up
2. Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 – 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS and 2496 - 2690 MHz BRS/EBS.
3. Approved Manufacturer: Andrew ION-B, ION-M or equivalent, in accordance with Section 1.05.

K. Fiber-Optic Remote Units: The Fiber-Optic Remote Unit converts the RoF signal back to radio over coax, as well as provides filtering so that multiple frequency bands can reside over the same passive cable and antenna infrastructure.

1. Characteristics

- a. Operating Temperature Range: +5 °C to +40 °C
- b. Impedence: 50 Ω
- c. Power Consumption: ≤ 105 watts, maximum
- d. Output Power per Carrier at Antenna Port:

Technology/Band (MHz)	Single carrier (dBm)
Analog 700	27
GSM 700	27
Analog 800 and 850	27
GSM 850 and 850	31
GSM 850 and 850 at band edges	29
iDEN 800 and 850	26
iDEN 800 and 850 at band edges	24
CDMA 800 and 850	29
CDMA 800 and 850 at band edges	27
Analog 900	29
iDEN 900	23
CDMA 1700	30
W-CDMA 1700	28
Analog 1900	31
GSM 1900	31
CDMA 1900	29
W-CDMA 1900	27

- e. MTBF (excluding external power supply): ≥ 160,000 hours
- f. Physical: The Remote Unit shall consist of the following:
 - 1) Ingress Protection: IP31 or equivalent
 - 2) Frequency Bands supported: 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1850 - 1995 MHz PCS
 - 3) Optical Port: 2xSC-APC connector (separated uplink/downlink)
 - 4) Antenna Port: Single 50 Ω N type female connector
 - 5) Auxiliary Ports: Two SMA female for future add-on modules
- g. Uplink Noise Figure:
 - 1) LMR 700, LMR 800, Cell850: ≤ 7.5 dB
 - 2) LMR 700, LMR 800, Cell850 at band edges: ≤ 9.5 dB
 - 3) LMR 900: ≤ 8.5 dB
 - 4) AWS: ≤ 7.5 dB
 - 5) PCS 1900 extended: ≤ 7.5 dB

2. Approved Manufacturer: Andrew ION-B, ION-M Series or equivalent in accordance with Section 1.05.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The contractor shall design, install, commission and test the ERRS in accordance with the manufacturer's instructions and recommendations.
- B. The contractor shall install the ERRS in accordance with the accepted SOW.

3.2 ACCEPTANCE TESTING

- A. Acceptance testing will be performed confirming the requirements of Section 1.09 have been met.
- B. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.

END OF SECTION 28 53 19

SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Remove topsoil and stockpile for later reuse.
- B. Excavate subsoil and stockpile for later reuse.
- C. Grade and contour site to elevations indicated on Drawings.
- D. Remove from site excess topsoil and subsoil.
- E. Fill under slabs on grade, foundations, sidewalks, and paving.
- F. Compaction.
- G. Excavation.
- H. Fill for over-excavation.
- I. Finish grade subsoil.
- J. Place, level, and compact topsoil.
- K. Building perimeter backfilling.

1.02 RELATED WORK

- A. Section 01 40 00, "Quality Requirements"
- B. Section 03 30 00, "Cast-in-Place Concrete"
- C. Section 31 23 33, "Piped Utilities - Basic Methods"
- D. Section 31 25 00, "Erosion and Sediment Control"
- E. Section 32 12 00, "Flexible Pavement"
- F. Section 32 13 00, "Rigid Pavement"
- G. Section 33 11 00, "Water Distribution"
- H. Section 33 30 00, "Sanitary Sewerage"
- I. Section 33 40 00, "Storm Drainage"

1.03 PROJECT RECORD DOCUMENTS

- A. Accurately record location of existing utilities remaining, rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 REFERENCES

- A. American Society for Testing and Materials (ASTM) C136- Method for Sieve Analysis for Fine and Coarse Aggregates.
- B. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. (2.49 kg) Rammer and 12 inch (304.8 mm) Drop.
- C. ASTM D422 – Particle Size Analysis of Soils.
- D. ANSI/ASTM D1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 lb. (4.54 kg) Rammer and 18 inch (457 mm) Drop.
- E. ASTM D4318 – Liquid Limit, Plastic Limit, and Plastic Index of Soils.
- F. ASTM D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- G. ASTM D2488 – Description and Identification of Soils (Visual – Manual Procedure).
- H. ASTM D1556 – Test Method for Density of Soil in Place by the Sand-Cone Method.
- I. ASTM D2922 – Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
- J. ASTM D3017 – Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- K. Ohio Department of Transportation (ODOT); Construction and Materials Specifications.

1.05 PROTECTION

- A. Protect trees, shrubs, lawns, and other features remaining as portion of final landscaping.
- B. Protect bench marks, existing structures, roads, sidewalks, and paving and curbs.
- C. Protect above or below grade utilities which are to remain.
- D. Repair damage.
- E. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.
- F. Protect bottom of excavations and soil adjacent to and beneath foundation, from freezing.

1.06 DEFINITIONS - The following govern earthwork materials, conditions, and operations.

- A. Stripping: Removal of existing surficial unsuitable materials (see definition) to their entire depth or as indicated.
- B. Excavation: Cutting, digging, removing, and wasting materials of every description, including soils, foundations, rock and whatever substance encountered to dimensions, limits, elevations and contours as indicated or required by either the Drawings or these Specifications.
- C. Rock: Boulders and detached stones having a volume of 2/3 cubic yard or more and any large masses of igneous, metamorphic, or sedimentary rocks, including firmly conglomerated deposits that cannot be removed with a 1 cubic yard capacity power shovel without drilling or blasting.
- D. Unsuitable Materials: Topsoil, loam, gumbo, mud, muck, silt, expansive clay, peat, soils with an organic content greater than 3% by weight, rubbish, debris, foundation and slab materials, paving materials, rock greater than 6 inches in diameter, soils with a maximum dry weight of less than 100 lbs. per cubic foot, vegetation and frozen or dry lumps. Expansive clay is any clay with a liquid limit in excess of 50 and/or Plasticity Index of 30 or greater.
- E. Unstable Materials: Materials which are not classified as unsuitable materials, but due to their condition of being wet, dry, or frozen, are unacceptable for use in fills.
- F. Imported Fill Material or Borrow: Approved soil materials from sources other than those made available by required excavation of Project. Unless specifically provided, no imported fill shall be obtained within limits of the Project site. Imported fill shall be free of unsuitable or unstable materials and shall be approved by the Testing Agency.
- G. Filling/Backfilling: Placing of approved soil materials in accordance with specified procedures and materials and in conformity with lines, grades, contours, cross-sections and elevations shown on Drawings or required by these Specifications.
- H. Subgrade: Undisturbed soil or compacted fill material upon which additional fill, sub-base or base course, footing, foundation, or slab cushion is placed.
- I. Engineered Fill: An acceptable soil, aggregate, or man-made material that is placed in a controlled manner to satisfy a defined compaction Specification. The defined compaction Specification would include a maximum lift thickness, an acceptable moisture content range, and a minimum required compaction percentage based on a moisture/density relationship (proctor or relative density).
- J. Pond Liner Material: Cohesive, on-site soils, USCS Classification CL or CL-ML. Soils shall be free of any unsuitable materials with greater than 70% passing the No. 200 sieve. Soils shall have a moisture content at or slightly above optimum. Based on the provided soils report, the on-site soil should be acceptable for use as pond liner material. Although, qualification tests will still be required to confirm acceptability.

1.07 QUALIFICATION TESTS

- A. Unless otherwise specified, Contractor shall arrange, supervise, and pay for a Testing Agency to perform the following required qualification tests.
 - 1. Qualification tests on each different fill material (both on-site and imported).
 - 2. Fill Materials: Provide the following information and qualifications tests for each fill material, including select on-site materials, prior to use on project site.
 - a. Location of sources for each required imported materials prior to delivery to site.
 - b. Analysis of fine and coarse aggregate ASTM C-136.
 - c. Particle size analysis of soils ASTM D422.
 - d. Liquid Limit, Plastic Limit and Plasticity Index, ASTM D4318 – cohesive materials only.
 - e. Proctor density or relative density information according to test method identified in the Compaction Requirements Schedule at the end of this Section.
- B. Fill material shall not be used until qualification tests have been completed and the Testing Agency has approved the fill material.

1.08 SUBMITTALS

- A. Comply with requirements of General and Special Conditions. Unless noted otherwise, submit two (2) copies of the following items:
 - 1. Submit material qualification tests for each fill material used and field density test reports directly from Testing Agency.
 - 2. Submit Testing Agency Certificate of Inspection and Compliance with Specifications for the following:
 - a. Bearing capacity for all footing/foundation subgrades.
 - b. Acceptability of both on-site and borrow fill materials, prior to use.
 - c. Acceptability of subgrade prior to fill placement.
 - d. Acceptability of fill placement.

1.09 SAMPLES

- A. Submit samples under provisions of General and Special Conditions.
- B. Submit 10 lb. sample of each type of fill to Testing Agency in airtight containers.
- C. Samples shall be submitted to the Testing Agency one (1) week prior to fill placement, in order to perform qualification tests.

1.10 LAYOUT

- A. Employ a Professional Surveyor, registered in State of ****Ohio****, to lay out and establish all lines and grades, including centerline of all structural columns.
- B. Erect control points prior to excavation. Protect existing control points.
- C. All surveying costs to be paid by General Trades Contractor.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Type A - ODOT Item 411 - Stabilized Crushed Aggregate.
- B. Type B – Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; graded in accordance with ANSI/ASTM C136, to the following:
 - 1. Minimum Size: 1/4 inch.
 - 2. Maximum Size: 5/8 inch.
- C. Type C – Sand: Natural river or bank sand, washed: free of silt, clay, loam, friable or soluble materials, or organic matter graded in accordance with ANSI/ASTM C136, within the following limits.

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	100
No. 14	10 to 100
No. 50	5 to 90
No. 100	4 to 30
No. 200	0

- D. Type D - Subsoil–Reused, select onsite or borrow soil materials conforming to the following:
 - 1. ASTM D2487 Soil Classification Groups GW, GC, GM, SW, SC, SM, CL, and ML.
 - 2. Less than 3% organic material by weight.
 - 3. Free of unstable or unsuitable material or construction debris.
- E. Type E - Coarse aggregate, washed gravel, carbonate stone, graded within the following limits.

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 inches	100
1 inch	95 to 100
1/2 inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

ODOT ITEM 703 #57.

- F. Type F - Topsoil: Fertile, friable, fine sandy clay loam, uniform in composition, capable of sustaining vigorous plant growth and free of subsoil, stones, lumps, clods, of hard earth, plants, plant roots, sticks, noxious weeds, slag, cinders, demolition debris or other extraneous matter over 1 inch in the largest dimension.
- G. Type G - Concrete: Structural concrete conforming to Section 03 30 00, "Cast-in-Place Concrete" with a compressive strength of 3000 psi.
- H. Type H - Drainage Fill: ODOT Item 703, #8.

- I. Type I – Controlled Fill:
 1. Cement: Per ODOT Specification 701.01 or 701.04.
 2. Fly Ash shall meet ASTM C-618, Class C or Class F except that requirements for moisture and pozzolanic activity are waived for Class F fly ash and Loss-On-Ignition (LOI) shall not exceed 12% for Class F fly ash.
 3. Fine Aggregate shall be natural or synthetic sand manufactured from stone, gravel, or air-cooled slag. The gradation of the sand shall meet the requirements of ODOT Specification 703.05, unless otherwise approved by the Engineer. The sand shall be fine enough to stay in suspension in the mixture to the extent required for proper flow. The Engineer reserves the right to reject the sand if a flowable mixture cannot be produced.
 4. Water used for mixture shall be free from oil, salts, acid, strong alkalis, vegetable matter, and other impurities that would have an adverse effect on the quality of the backfill material.
 5. The mix design including synthetic sand shall be evaluated as non-corrosive by ASTM-674.

- J. Type J - Aggregate Base: ODOT Item 304 - The aggregate shall be crushed carbonate stone or crushed gravel, graded in accordance with ANSI/ASTM C136 within the following limits:

<u>Sieve Size</u>	<u>Total Percent Passing</u>
2 inch	100
1 inch	70 to 100
3/4 inch	50 to 90
No. 4	30 to 60
No. 30	9 to 33
No. 200	0 to 13

Prior to placing, aggregate shall have reasonably uniform moisture content at or near optimum for compaction.

- K. Type K – Bank Run Gravel: The material shall consist of bank run sand and gravel, free of frozen materials, wood and rubbish. It shall have no more than 20% passing the No. 200 sieve and no particle size larger than 3 inches. Sources of borrow shall be designated well in advance of construction and bulk samples procured and tested in a laboratory to determine compaction characteristics so that this data will be available for the control of fill when construction commences.

- L. Type L - Nonstabilized Drainage Base: Aggregate shall be crushed carbonate stone or gravel from approved sources graded in accordance with ASTM C136 within the following limits:

<u>SIEVE SIZE</u>	<u>PERCENT PASSING</u>		
	<u>Type "NJ"</u>	<u>Type "IA"</u>	<u>Type "CE"</u>
1 1/2 inch	100	-	100
1 inch	95 to 100	100	90 to 100
3/4 inch	-	-	55 to 90
1/2 inch	60 to 80	50 to 80	40 to 75
3/8 inch	-	-	30 to 65
No. 4	40 to 55	-	15 to 40
No. 8	5 to 25	10 to 35	5 to 25
No. 16	0 to 8	-	0 to 12

<u>SIEVE SIZE</u>	<u>PERCENT PASSING</u>		
	<u>Type "NJ"</u>	<u>Type "IA"</u>	<u>Type "CE"</u>
No. 50	0 to 5	0 to 15	0 to 6
No. 200	-	0 to 6	-

2.02 CONSTRUCTION FENCE

- A. Plastic construction fence, orange in color, with the following properties:

Material - Co-polymer
 Typical Aperture Size - 1.3 inches x 1.3 inches
 Minimum Tensile Strength:
 MD 850 lbs./ft. width
 TD 1050 lbs./ft. width
 MD 4850 psi
 TD 5810 psi
 Junction Strength - 90% of rib strength (minimum)
 Nominal Porosity - 75%
 Ultraviolet Resistance - Fully stabilized
 Temperature Range - -22 degrees F to 150 degrees F
 Tensar Safety Grid or equal

PART 3 EXECUTION

3.01 GENERAL

- A. The following Specification shall be considered as general criteria for earthwork operations. In those instances where field conditions arise which are not adequately covered by these criteria, instructions for that specific condition will be issued by the Architect/Engineer.
- B. Dust Control:
1. Use all means necessary to control dust on and near the work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site.
 2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site.
- C. Grading operations shall be performed in such a manner as to direct and control storm water runoff so that no damage or erosion occurs. Saturation of cut and fill areas shall be prevented by directing storm water runoff and not allowing ponding to occur. Fills are to be crowned as required to maintain drainage at the end of each work day. Existing drainage routes shall not be choked or obstructed until new ones are available. Temporary culverts, pumps or other equipment shall be used to facilitate drainage of fills during construction, failure to drain storm water shall not be grounds for delay of this contract due to saturated site conditions. The Contractor shall remove and dispose of saturated materials in excess of allowable moisture content at compaction and shall maintain the project schedule at all times.

- D. Dewatering: All excavation, construction, and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining, and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Associate/Engineer and his/her decision shall be binding upon the Contractor. If the Associate/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Associate/Engineer then agrees with the adequacy of the operating condition.
- E. Site Grading:
 - 1. Existing Conditions: Visit site and verify earthwork requirements prior to commencing work.
 - a. Existing Grades: Existing grades and contours are indicated on Drawings and represent the best information available on actual existing site conditions. Verify existing grades prior to commencing work. Commencement of work is construed as acceptance of grades and/or contours as correct.
 - b. Subsurface Conditions: Results of explorations are for use in estimating work quantities and design parameters, and for the information of the Bidders only, and neither the Owner nor the Associate/Engineer will be responsible for variations in subsoil deposition and quality or for changes which may have occurred after the investigations were made.
 - c. See logs of explorations for indication of existing soil and rock boundaries.
 - 2. Required contours and elevations are indicated and noted on the Drawings. Should indicated figures conflict with actual conditions and contours, notify the Associate Engineer and await his/her directions before proceeding.

3.02 PROTECTION OF PERSONS AND PROPERTY

- A. Barricade open excavations occurring and post with warning lights from dusk to dawn each day and as otherwise required.
- B. Erect construction barriers to prevent public access to the area of the Work. Maintain in place throughout the new construction operations. Erection, maintenance, alterations, and removal of the barriers shall be the responsibility of the Contractor.
- C. Do not close or obstruct streets or sidewalks without the proper permit. Conduct operations with minimum traffic interference.
- D. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- E. Protect public and private property adjacent to and on the job site, including vents, utility lines, roadways, sidewalks, light standards, hydrants, and trees not indicated for removal. Repair damage to the property at no cost to the Owner.

- F. Notify local authorities having jurisdiction of existing damage in adjacent streets or improvements such as paving, curbs, gutters, sidewalks, and alley surfacing, prior to start of demolition work. If damage to streets and improvements is discovered after work has commenced, and such damage was not reported before start of work, the Contractor will perform and pay for the necessary repairs.
- G. Maintain and preserve utilities transversing premises as long as they are required. Backfill and compact all excavation made for removal of utilities.
- H. Seal or cap all utility lines leading from demolished structures in accordance with regulations of authorities having jurisdiction.
- I. Before starting work related to existing utilities such as electrical, sewer, water, heat, gas and fire lines that will temporarily discontinue or disrupt service to any existing building, notify the utility companies 72 hours in advance and obtain approval in writing before proceeding with this phase of work.
- J. Earthwork:
 - 1. Stability of temporary excavations:
 - a. All excavations shall be in accordance with OSHA requirements.
 - b. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
 - c. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
 - 2. Shoring:
 - a. Except as specified elsewhere, provide all shoring required for earthwork or required as a result of earthwork for safety of workers, existing structures, public or adjacent properties.
 - b. Provide materials for shoring and bracing in good serviceable condition.
 - c. Establish requirements for shoring and bracing to comply with local codes and authorities having jurisdiction.
 - d. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
- K. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known below grade utilities. Stake and flag locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass through work area.

- E. Notify utility company to remove and relocate utilities.
- F. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Associate/Engineer.

3.04 ROUGH GRADING AND EMBANKMENT CONSTRUCTION

A. Rough Grading:

1. Site clearing and grubbing shall be done prior to any rough grading. All debris and deleterious material shall be removed from areas to be filled or backfilled.
2. Dispose of excess excavated material or supply additional suitable material as necessary to complete the rough grading to the required elevations.
3. The finished subgrade surface shall be reasonably smooth and free from irregular surface changes and shall be no more than one tenth (0.1) of a foot above or below the approved subgrade elevation.
4. Newly graded areas shall be protected from the action of the elements. Any damage that may occur as a result of natural causes or any construction activities, prior to the acceptance of the work, shall be repaired and grades re-established to the required elevations and slopes.
5. During the performance of rough grading operations, the subgrade shall be examined critically; and any areas discovered which are soft and unstable or exhibit other unusual conditions, shall be immediately pointed out to the Testing Agency. Upon the direction of the Testing Agency, these areas shall be excavated to such depths as may be necessary to insure satisfactory supporting properties.
Removal of unsuitable material and its replacement as directed shall be paid on basis of contract conditions relative to changes in work.
6. In general, subgrade shall be established at the following levels:
 - a. For Pavement Areas: Finish grade less the thickness of pavement and base material.
 - b. For Structures: Finish floor elevation less the thickness of the slab and any porous fill.
 - c. For Lawn Areas: Finish grade less a minimum 6 inches topsoil thickness.
 - d. Sidewalks and Plazas: Finish grade minus sidewalk and base thickness.
 - e. Landscape Areas: Finish grade less topsoil and mulch. Refer to "Schedule of Locations" Section for topsoil depths. Refer to _____ Section for mulch depths.

B. Compaction and Proof Rolling of Subgrade:

1. All subgrade surfaces shall be proof rolled by means of heavy equipment (minimum 30 ton dual axle truck dump) to locate and permit timely correction of the subgrade deficiencies. Proof rolling shall be witnessed by the Testing Agency.
2. In cut sections, proof rolling of the subgrade surface shall be done to determine the location and extent of areas below subgrade surface that may require subgrade undercutting. Should any portion of the cut subgrade surface fail to provide satisfactory support for the proof rolling operation, the Testing Agency may order corrective undercut and backfill work done. Corrective undercut and backfill will be paid for as specified in 3.04 A.5.

3. In embankment sections, prior to placing the embankment, proof rolling on the subgrade surface shall be done to determine the uniformity of the compaction below the subgrade and any deficiencies requiring corrective work. Any deficiencies discovered during proof rolling operations shall be corrected in a manner satisfactory to the Testing Agency. Corrective undercut and backfill will be paid for as specified in 3.04 A.5. After all corrective work has been completed, the surface shall be proof rolled again. Corrective work shall not be considered complete and acceptable until the embankment shows satisfactory and uniform response to the proof rolling operations.

C. Embankment:

1. After proof rolling of the existing subgrade has been completed, the surface of the area to be filled shall be scarified to a depth of 6 inches. An initial 3 inch layer of fill material shall then be spread over the scarified surface and the entire area compacted as specified.
2. Areas requiring fill shall be filled and backfilled using suitable materials compacted in layers not to exceed the following (all thicknesses are loose thicknesses):
 - a. Within building areas - 8 inches.
 - b. Under pavements, sidewalks, or plazas - 8 inches.
 - c. General site fill - 12 inches.
3. The moisture content of placed material shall not deviate from the optimum by more than two percent (+/-2%). Moisture content of any material which displays pronounced deformation under construction equipment shall not exceed the optimum. Drying of wet soil shall be expected by the use of plows, discs, harrows, or other approved methods. If additional water is required, it should be uniformly distributed through the use of approved water wagons and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.
4. Amount of Compaction: After each layer has been placed, mixed, and spread evenly, it shall be thoroughly compacted to not less than the percent shown under the Compaction Requirements Schedule in accordance with ASTM Method D-698 D1557 at a moisture content of $\pm 2\%$ of optimum.
5. Compaction of Embankment Layers: Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to ensure that the required density has been obtained.
6. Density Tests: Field density tests shall be made by the Testing Agency per the Compaction Requirements Schedule. Density tests shall be taken in compacted material below the disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below the required density, the particular layer or portion shall be reworked until the required density has been obtained.
7. Seasonal Limits: No fill material shall be placed, spread, or rolled while it is frozen or thawing or during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not resume until the Testing Agency indicates that the moisture content and density of the previously placed fill are as specified.
8. The embankment and borrow areas should be maintained in a freely draining condition at all times. Proper drainage should be provided for any water or springs which may be encountered.
9. When the embankment meets the natural grade of a slope, a bench shall be cut in the existing slope. These cuts are to serve as keys to connect the existing grade with the newly placed fill.
10. Frozen fill material or any suitable fill shall not be placed on frozen, or snow covered surfaces.

11. If soft, yielding material is encountered in embankments as a result of trapping water, and cannot be satisfactorily stabilized by moisture control and compaction, the unstable material shall be excavated to the depth required by the Testing Agency. The excavation shall then be filled with suitable material and compacted in accordance with the requirements outlined above.
12. Rock – Rock fill shall be placed in not to exceed 3 foot thick horizontal lifts. Rock which cannot be incorporated into lifts of 3 feet shall be reduced in size until it can be so incorporated. Lifts made up principally of small rock shall be rolled in a similar manner as that required for shale and siltstone. Beneath the footprints and 5 foot perimeter of the proposed buildings, the top 3 feet of fill embankment shall be constructed of a non-organic soil fill. Beneath proposed pavements, the top 1 foot shall consist of a soil fill. Maximum rock size shall be 18 inches.
13. When embankment is to be placed and compacted on hillsides or where new embankment is to be compacted against existing embankments, slopes that are steeper than 8:1 shall be continuously benched over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment.

D. Ponds:

1. Perform cut/fill operations to the above Specifications.
2. Establish pond elevations to 2 feet below finished grade elevations as noted on Drawings.
3. The Testing Agency shall observe the soils at this elevation and indicate any apparent sand and gravel seams to be removed. Excavate sand and gravel seams until suitable pond liner material is encountered. Backfill excavation with suitable pond liner material. The area of soils to be observed shall extend to 1 foot above the high water elevation, as noted on the Drawings. Corrective undercut and backfill of sand and gravel seams will be paid for as specified in paragraph 3.04, A.5.
4. Establish finished pond elevations by placing a minimum of three (3) 8 inch lifts of suitable pond liner material. Each lift shall be compacted with a sheepsfoot roller making a minimum of two (2) passes in perpendicular directions. The pond liner material shall be compacted to 98% Standard Proctor Density and the moisture content shall be at or above optimum moisture content.
5. The 2 foot thick pond liner material shall be installed on the bottom of the pond and along the pond embankment to a height of 1 foot above the high water elevation noted on the Drawings.
6. After finished grades have been established, the surface shall be rolled with a vibratory steel drum roller or a fully loaded 30 ton truck or similar pneumatic tired vehicle to smooth the surface.

3.05 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, relandscaped, or regraded and stockpile in area designated on site. Seed stockpile in accordance with Section 31 25 00, "Erosion and Sediment Control."

3.06 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Excavate subsoil and whatever material encountered required to accommodate building foundations, slabs-on-grade, paving and site structures, and construction operations.
- C. Machine slope banks.
- D. Excavation cut not to interfere with normal 45 degree bearing splay of foundation.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Hand trim excavation. Remove loose matter. Compact bottoms of excavations with a plate vibrator if so directed by the Testing Agency. All excavations to be protected as work progresses.
- G. Remove lumped subsoil, boulders, and rock greater than 1/3 cubic yard measured by volume.
- H. Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- I. Correct unauthorized excavation at no extra cost to Owner.
- J. Correct areas over-excavated by error at no extra cost to the Owner.
- K. Remove all excavated material from within building area.
- L. Contractor solely responsible for means and methods employed to excavate materials encountered on site.
- M. It is intent of Contract Documents that excavation cuts be used as forms for vertical surfaces of footings and column pads. Soil conditions which prevent vertical cuts, or excavation characteristics which require forming concrete are responsibility of General Trades Contractor.
- N. Prior to placing concrete for the footings, all foundation excavations shall be inspected and approved by the Testing Agency, for the bearing capacity indicated on the Drawings.

3.07 BUILDING FILL AND BACKFILL

- A. Remove any accumulated debris from excavations before backfilling.
- B. Backfill on interior side of perimeter footings and foundation walls and on both sides of interior footings and foundation walls with Type A or Type H fill. Place in 8 inch layers, compact with vibratory compaction equipment to 98% of the maximum dry unit weight.
- C. Construct gravel base under floor slab of Type A, Type E, or Type H fill within building area to provide a layer of minimum 4 inch thickness. Shape subgrade and gravel base for floor slab construction per Drawings.

- D. Within all areas to receive asphalt or concrete pavement immediately adjacent to exterior walls, backfill on exterior of foundation walls with Type A, Type H, Type J, or Type K fill. Place in 8 inch layers, compact with vibratory compaction equipment to 98% of the maximum dry unit weight.
- E. Backfill at all other exterior foundation walls with suitable excavated material. Place material in 8 inch layers and compact to 98% of the maximum dry unit weight. Backfill to level slightly above grade at building exterior to drain water away from building. At walls with foundation drains and/or weep holes, provide Type A or Type H material for extent indicated on structural drawings. Place material in 8 inch layers and compact to 98% of the maximum dry unit weight. In lawn areas, place a 2 foot cohesive clay cap from the bottom of the topsoil to a depth of 2 feet.
- F. Exercise caution to avoid damage to foundation damp proofing during backfill and compaction operations.

3.08 SUBSOIL PREPARATION FOR PLACING TOPSOIL

- A. Eliminate uneven areas and low spots. Remove debris, roots, branches, stones, in excess of 2 inches in size. Remove subsoil contaminated with petroleum products.
- B. Scarify subgrade to depth of 6 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.09 PLACING TOPSOIL

- A. Place topsoil in areas where seeding, sodding, and planting is scheduled.
- B. Use topsoil in relatively dry state. Place during dry weather.
- C. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.
- D. Remove stone, roots, grass, weeds, debris, and foreign material while spreading.
- E. Manually spread topsoil around trees, plants, building and curbs to prevent damage.
- F. Roll placed topsoil.
- G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.10 SCHEDULE OF LOCATIONS

- A. The following paragraphs identify compacted topsoil thicknesses for various locations.
 - 1. Seeded Areas: 6 inches minimum
 - 2. Sod: 6 inches minimum
 - 3. Shrub Beds: 18 inches minimum
 - 4. Flower Beds: 12 inches minimum
 - 5. Planter Boxes: To within 3 inches of box rim

3.11 CONTROLLED DENSITY FILL PLACEMENT

- A. Pipe Filled in Place: This work consists of leaving specified lengths in place and constructing masonry bulkheads or placing precast stoppers and filling the pipe internal void. The fill material shall be a cement controlled density fill mix.
- B. Mix Proportioning: The initial trial mixture shall consist of the following quantities of materials per cubic yard:

	Type I	Type II	Type III
	100	(100)	(50)
Cement	100 lb.	50 lb.	100 lb.
Fly Ash, Class F	250 lb.	250 lb.	2000 lb.
Fly Ash, Class C	0 lb.	0 lb.	0 lb.
Sand (SSD)*	2850 lb.	2910 lb.	0 lb.
Water (Maximum)	500 lb.	500 lb.	725 lb.

* saturated-surface-dry

These quantities of materials are expected to yield approximately 1 cubic yard of mixture of a flowable consistency. The proportioning of materials shall be the responsibility of the Contractor. Adjustments of the proportions shall be based on maintaining the total absolute volume and proportioning shall insure that unconfined compressive strength at 90 days does not exceed 150 PSI (10.8 TSF). The minimum unconfined compressive strength shall not be less than 50 PSI (3.6 TSF). The Contractor may be required to provide test data from a laboratory inspected by the Cement & Concrete Reference Laboratory (CCRL) and approved by the Engineer that shows the proposed proportioning will meet strength limitations.

- C. Mixing Adjustments: To expedite consolidation of Type I or Type II mixtures as defined above, it will be necessary for bleed water to appear on the surface immediately after the mixture is struck off. A delay in bleeding indicates there are too many fines in the mixture, so the fly ash quantity shall be reduced in increments of 50 lbs. until mixture is bleeding freely. Approximately 60 lbs. of sand shall be added to replace each 50 lb. increment of fly ash to maintain the original yield.

To produce a flowable mixture, it may be necessary to make one or more cubic yard trial batches at different water contents. Mixture is too dry when cracks develop in the mixture as it flows into place.

- D. Flow Test: A test for the flow consists of filling a 3 inch diameter by 6 inch high open-ended cylinder, on a smooth level surface, to the top with flowable mixture. If necessary, strike off the top of the cylinder so the mixture is level. Pull the cylinder straight up, within 5 seconds, and measure the approximate spread of mixture. The diameter of the material spread shall be at least 8 inches.
- E. Pumping: The mix proportioning of Types I and II are not designed to be pumpable. If the Contractor elects to pump the flowable mixture, fly ash will need to be added until the amount of cement and fly ash is 750 lbs. Fine aggregate shall be reduced to maintain absolute volume of the mixture.

- F. **Mixing Equipment:** Sufficient mixing capacity and delivery equipment shall be provided to permit the CDF mixture to be placed without interruption as much as practical. CDF mixtures may be placed in intermittent horizontal lifts without having to provide for uninterrupted mixture placement as approved or directed by the Engineer.
Delivery equipment shall be as follows:
Type I and Type II CDF mixtures shall be delivered and placed from ready mixed concrete trucks or volumetric mobile concrete mixers. These mixtures may be pumped if modified in accordance with above.
Type III CDF mixtures may be delivered and placed from dump trucks, ready mixed concrete trucks, volumetric mobile concrete mixers, conveyer lines, or pumping.
- G. **Placing Mixture:** CDF mixture shall be discharged from mixing and delivery equipment by any reasonable means into the space to be filled. The fill material shall be brought up uniformly to the fill line shown on the plans or as directed by the Engineer. Placing of any material over low strength mortar backfill may commence, as specified herein, as soon as the surface water is gone, or as directed by the Engineer.
- H. **Limitations of Operations:**
1. Mixture shall not be placed on frozen ground.
 2. Mixture shall be protected from freezing.
 3. Each filling stage shall be as continuous as is practicable.
 4. Temperature affects the cure time of CDF. As temperatures near freezing or below additional time will be needed for the proper curing of the material prior to any paving type of operations.

3.12 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed by an independent Testing Agency retained by the Contractor and approved by the Owner. Retained by the Owner.
- B. Tests and analysis of fill material will be performed in accordance with ASTM D698 / D1557 and with Division 1.
- C. Compaction testing will be performed in accordance with ANSI/ASTM D2922 and D3017 and with Division 1.
- D. Field density test reports shall clearly identify the following information for each test:
1. Horizontal and vertical location of test
 2. Material type being tested
 3. Proctor test method
 4. Maximum proctor density
 5. Specified density
 6. Optimum moisture content
 7. Field test method
 8. Actual moisture content
 9. Tested density
 10. Pass/fail indication
- E. Do not submit reports of failing tests without follow-up report of reworked area and passing retest. Submitted test reports without specified information will be returned for revisions and resubmittal.

- F. Submit rough draft of daily Field Observation Report to the Engineer via facsimile the day of the field visit. Follow up with formal report.
- G. Excavate, replace at near optimum moisture, recompact and retest all areas failing to meet compaction requirements at no additional cost.

3.13 SCHEDULE OF FILL MATERIAL AND COMPACTION REQUIREMENTS SCHEDULE

- A. Compact fill materials to meet the following minimum Standard Modified Proctor Density, ASTM D698 /ASTM D1557.

LOCATIONS	MATERIAL TYPES												COMPACTION REQUIREMENTS			
	A	B	C	D	E	F	G	H	I	J	K	L	%	M	U	
	I	P	S	S	I	T	C	I	C	I	B	N	C	I	N	
	T	E	A	U	T	O	O	T	D	T	A	S	O	N	I	
	E	A	N	B	E	P	N	E	F	E	N	D	C	I	I	
	M	R	D	S	M	S	R	M		M	K	B	O	N	T	
	4	A		O	7	O	E	7		3	R		A	M	A	
	1	V		I	0	I	T	0		0	U		C	T	R	
	1		3	3		4		T	E							
					5			8			G		I	S	/	
					7							O	T	L		
												N	I	I		
												C	I	F		
												O	N	T		
												A				
												C				
												O				
												%				
													M			
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													T			
													A			
													R			
													E			
													/			
													L			
													I			
													F			
													T			
Aggregate base under exterior concrete slabs, sidewalks, and plaza areas.	X									X		X	98%	1/1000 SY		
Foundation wall backfill as defined in "Building Fill & Backfill."	X							X					98%	1/100 SY		
Areas to receive asphalt or concrete pavement or walks immediately adjacent to exterior walls.	X							X		X	X		100%	1/500 SY		
Aggregate base beneath interior floor slab.	X				X			X					100%	1/500 SY		
General site fill, both paved and non-paved areas, utility trenches outside paved areas, utility trenches under pavement in excess of 48 inch depth, corrective backfill, areas to receive lawns immediately adjacent to exterior walls.													98%	1/1000 SY		
Sewer bedding.					X								N/A	N/A		
Underdrains, french drains, aggregate drainage material behind site retaining walls.					X			X					N/A	N/A		
Abandoned utilities, trench backfill where shown on drawings.									X				N/A	N/A		
Utility trenches less than or equal to 48 inch depth under pavement.	X									X			100%	1/300 LF		
Aggregate base beneath asphalt roads.										X			100%	1/500 SY		
Fill beneath floor slabs and aggregate base or foundations, corrective backfill for over excavation, or fill for removed foundations.	X			X						X	X	X	100%	1/500 SY		
Finish slopes, lawn areas, planters.						X							N/A	N/A		
Sewer Encasement							X									

END OF SECTION

SECTION 31 21 13
RADON MIDIGATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, equipment and service necessary to complete all work involved in radon mitigation.
- B. Provide all work necessary to reduce and maintain radon concentration levels below radon levels required] in various buildings specified herein. Perform mitigation system installation, and perform post-mitigation testing and monitoring for radon.

1.02 RELATED SECTIONS

- A. Electrical: Division 26.
- B. Plumbing: Division 22.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Regularly engaged in radon mitigation work for a minimum of 5 years.

1.03 SUBMITTALS

- A. Product Data: Submit for all items.

PART 2 PRODUCTS

2.01 MATERIALS

- A. See following attached Radon Mitigation Harriet's Hope Project Specification and products,

PART 3 EXECUTION

3.01 PREPARATION

- A. Examine conditions of substrates and installation conditions. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Verify and coordinate mechanical and electrical services.

3.02 INSTALLATION

- A. See Radon Mitigation Project Specification
- B. Install all components and system per manufacturers recommendations.
- C. Route radon mitigation systems piping so as not to interfere with the daily operations and functions of the building occupants. Keep visibility of the systems to a minimum. Enclose each radon mitigation system in occupied spaces, however, all operating components must be accessible for maintenance and repair.
- D. Mitigation system discharge points must be as specified in ANSI/AARST RMS-LB and EPA 402-R-93-078.
- E. Test each radon mitigation system for effectiveness after activation of the radon mitigation system. Perform all testing in accordance with ANSI/AARST MALB, and all local, state and Federal requirements.

END OF SECTION



CMHA

Seasons Grove/Cobblestone Manor

1050 Lamplighter Drive

Grove City, OH 43123

Radon Mitigation SPECIFICATIONS To Meet The Ohio Department of Health and ANSI/AARST CC-1000-2018 Soil Gas Control Systems in New Construction of Buildings

1. The Radon Mitigation System (SSDS) shall be installed with an air channeling material, such as VaporMat or an engineered equivalent under the concrete slab of the facility. The air channeling material shall be installed around the entire inside perimeter of the foundation footer within 2-4', as well as cross sections every 20' across the entire length of the building. As Needed additional air channeling lines shall run across the width of the building connecting the extraction point locations. Recommend the air channeling material to be installed on top of the last layer of backfill, right before the vapor barrier is installed and the slab is poured. Specifically, VaporMat air channeling material can be installed under footers/thickened slabs. See drawing for proposed layout and the manufacturer's spec. sheet for reference and installation guidelines.
2. The SSDS will consist of a total of 7 Sch. 40 4" PVC vent risers. The exact location of the vent risers has yet to be determined. The vent risers need to divide the footprint of the facility as evenly as possible. The vent risers need to run as vertical of a route as possible up through a designated wall chase through the flat roof or attic roof. The General Contractor's Roofing contractor to seal roof penetrations. The exact vent riser wall chase locations to be determined by a coordinated effort from the Architectural firm, General Contractor and Licensed Radon Mitigation Contractor.
3. The sub slab vent piping and the vertical riser piping of the SSDS recommended to 4-inch diameter SCH-40 PVC piping. If 4-inch PVC is not feasible to fit in all wall chases, then 3-inch SCH-40 PVC can be installed. However, the number of vent risers will need to increase from 7 to 11 if 3" PVC is used for all vent risers. All joints and fittings should be properly chemically bonded/sealed following manufacturer instructions.



4. The licensed radon contractor shall create a suction pit underneath the slab at each suction point by excavating approximately 1 cubic foot (approximately 5-10 gallons) from around the vent riser pipe.
5. All joints in and penetrations through the slab shall be sealed against air leakage to include openings around plumbing, SSDS vent pipes, mechanical piping, structural components, electrical conduit, and any other gaps that are open to the soil or gas permeable layer.
6. Sealing of penetrations shall be achieved with caulk that complies with ASTM C920 class 25 or higher, closed cell gasket materials, or an equivalent method. If caulk is used to seal a crack, joint, or opening greater than ½ inch in width, foam backer rod or other comparable filler material shall be inserted into the joint to support the caulk as it cures.
7. PVC pipe joints shall be solvent welded in accordance with the pipe manufacturer's instructions with solvent cement conforming to ASTM D2564.
8. Vertical risers must be supported in accordance with minimum standards established by local plumbing codes and must be supported vertically not less than every 10 feet and 4 to 6 feet horizontally. All supports shall inhibit both lateral and vertical movement of piping that could result in compromised joint collections/water traps and avoid locations that are susceptible to damage or blunt force impact.
9. Vertical riser piping shall be visibly labeled "Radon Mitigation System Vent Pipe" on each floor level of the building. The lowest label shall be placed at eye level.
10. The venting terminus of the riser pipes shall terminate a minimum of 24 inches above the flat roofline. Recommend installing a Varmint Guard screen or engineered equivalent on top of each vent riser.



11. Riser pipe exhausts shall be spaced a minimum 20 feet from any opening in the building (doors, windows, ventilation, air intakes, etc.) or exterior flooring (decks, sidewalks, balconies, etc.) or must be a minimum of 10 feet above or horizontally from the building openings or exterior flooring.
12. As necessary or requested, the passive radon vent risers shall be activated with an approved radon mitigation fan unit based on air pressure field diagnostics and pressure readings from U-tube manometers. Recommend RadonAway's RP 265 Fan, or an engineered equivalent.
13. The radon mitigation fan requires an on and off disconnect switch within 6 feet of each fan's location on the roof top or in the attic. A licensed electrician shall provide a continuous power source for each radon fan. See manufacturer's spec. sheet for electrical information for the model of fan installed.
14. A system O&M plan shall be provided to the property owners. As necessary, install a fan failure indicator (U-tube Manometer Or Magnehilic Manometer), on the vent riser. Fan failure indicator must be placed somewhere in an accessible and visible location below the fan.
15. If applicable, sump pits or other pit openings in interior floors that connect to sub slab air and require access for maintenance shall have a rigid lid that is sealed with a gasket material or silicone caulk and mechanically fastened in a manner to facilitate removal. The sump lid shall be made of sturdy and durable plastic such as polycarbonate plastic and designed to support any anticipated load on the lid. Penetrations through the lid (if any) shall be sealed with a caulk complying with ASTM C920 class 25 or higher (or equivalent). Sump lids shall be labeled "Component of Vapor Mitigation System" and "Return to a Closed Condition if Opened, Accessed, or Damaged". Labels shall be placed on the sump lid.
16. Note to the General Contractor, a soil gas retarder or vapor barrier is required to completely cover the area beneath the concrete slab. The soil gas retarder or vapor barrier shall be placed between the gas permeable layer and the concrete slab. The soil



gas retarder or vapor barrier shall be polyethylene sheeting no less than 6 mils in thickness.

17. Recommend the SSDS installation to be performed by a licensed Ohio Department of Health licensed radon contractor. If vent risers are activated, a licensed radon mitigation specialist must install the appropriate fan units.

18. Radon Systems recommends an indoor short term radon test to meet current Ohio Department of Health guidelines to be performed once the facility is in livable conditions. A ODH licensed radon tester must perform the short term radon testing. Testing shall be performed in accordance with applicable state or local requirements.



STATE OF OHIO
DEPARTMENT OF HEALTH

Bureau of Environmental Health and Radiation Protection
Indoor Radon Program

Hereby Approves:

Insul-Tech Inc dba Radon Systems

as a

Radon Mitigation Contractor

This license is issued pursuant to Chapter 3723 of the Ohio Revised Code and 3701-69 of the Ohio Administrative Code and in reliance upon statements and representations made heretofore by the licensee.

License Number: **RC260**

Amendment Number: **2**

Expiration Date: **3/30/2024**

In witness thereof:

A handwritten signature in black ink, appearing to read "Vanderhoff MD", is written over a light gray rectangular background.

Bruce Vanderhoff, MD, MBA
Director of Health



STATE OF OHIO
DEPARTMENT OF HEALTH

Bureau of Environmental Health and Radiation Protection
Indoor Radon Program

Hereby Approves:

James Michael Brenneman
2320 Broadmoor Drive

Elkhart, IN 46514

as a

Radon Mitigation Specialist

This license is issued pursuant to Chapter 3723 of the Ohio Revised Code and 3701-69 of the Ohio Administrative Code and in reliance upon statements and representations made heretofore by the licensee.

License Number: **RS421**

Amendment Number: **2**

Expiration Date: **3/2/2024**

In witness thereof:

Bruce Vanderhoff, MD, MBA
Director of Health

Fold

<p>Your license card is valid for a period of two (2) years, as indicated by the expiration date on the card. Your card must be present on any project site where you are conducting radon-related work.</p>		<p>State of Ohio - Department of Health Bureau of Environmental Health and Radiation Protection Radon Mitigation Specialist</p>
<p>All questions regarding your license should be directed to (614) 752-4425</p>	<p>James Michael Brenneman 2320 Broadmoor Drive</p>	<p>Expiration Date 3/2/2024</p>
<p>To verify licensure please visit: www.odh.ohio.gov</p>	<p>Elkhart, IN 46514</p>	<p>License Number RS421 Amendment # 2</p>
<p>If found, please return to: Ohio Department of Health 246 North High Street Columbus, OH 43215</p>	<p>This license is issued pursuant to Chapter 3723 of the Ohio Revised Code and 3701-69 of the Ohio Administrative Code</p>	
<p>HEA 5520 11/11</p>	<p>2460371</p>	



VAPORMAT™ FOR RADON, MOISTURE AND VOC REDUCTION



- SAVES TIME & MONEY
- EASY TO INSTALL
- >40% RECYCLED PRE-CONSUMER MATERIAL
- LEED V4 CREDIT ELIGIBLE (1-2 POINTS)
- COMPLIES W/RRNC 2.0 & ASTM E-1465





MEETING THE STANDARDS WITH VAPORMAT™

RADON REDUCTION IN NEW BUILDING CONSTRUCTION

New construction radon standards, including the U.S. EPA-recommended ANSI-AARST Standard, RRNC 2.0: Reducing Radon in New Construction of 1 & 2 Family Dwellings and Townhouses , call for the installation of a soil gas collector beneath the slab.

An increasing number of mitigation and construction contractors are using soil gas collector matting, choosing it for its ease installation. In addition, RRNC 2.0 (Section 402.1.1.2) recommends its use and further states: “The *soil gas collector* shall consist of a strip of geotextile drain matting not less than 10 feet [3 m] in length and having a cross sectional area of not less than 12 square inches [77 sq. cm]. The strip of matting shall be placed on top of the soil or in a trench.”

VAPORMAT, available in 0.5-inch and 0.9-inch thicknesses, meets and exceeds RRNC 2.0 and other standards for the collection of radon, moisture, and other toxic vapors that come from beneath the slab. It works effectively with both passive and active soil depressurization systems.

VAPORMAT™ INFORMATION AND SPECIFICATIONS

The matting is enveloped in the filter fabric and is comprised of 90% air space, allowing the radon and other soil gases and vapors to be channeled to the riser pipe connection tee. Two sizes of VAPORMAT™ are available: 040-48 and 080-15.

VAPORMAT™	040-48	080-15
Thickness	0.4 inches	0.8 inches
Width	48 inches	15 inches
Roll Length	50 feet	45 feet
Rolls per Pallet	10	24
Compressive Strength	>2,500 PSF ¹	>2,500 PSF*
Determined Flow Rate	11.856 gallons/Min./Ft. ²	11.856 gallons/Min./Ft. ²
Percent Recycled	>40% (Pre-Consumer Material)	>40% (Pre-Consumer Material)

¹ Concrete Slab typically 30-60 PSF

² Per ASTM 4716



VAPORMAT™ APPLICATIONS:

- Typically used in place of perforated piping for negative pressure field extension under a concrete slab or radon vapor barrier.
- Where a pressure field is required across obstacles or over distances.
- In conjunction with sand and/or gravel.

BENEFITS / FEATURES:

- Reduces radon, moisture and other toxic vapor levels in the living space of a home when used in conjunction with an active fan.
- Reduces the potential for mold and mildew problems when used in conjunction with an active fan.
- Maintains air flow communication across grade beams, downturns, footers and distant corners when used in conjunction with an active fan.
- Reduces the need for an exhaust fan or basement dehumidifier reducing lifetime energy costs when used in conjunction with an active fan.
- Installation is easy saving time and money over other options.
- Complies with standards and building codes: IRC Appendix F, RRNC 2.0 and ASTM E-1465.
- Manufactured in USA.
- Shortens concrete slab cure time significantly when used in conjunction with an active fan.
- For pouring slabs in existing dirt floor basements or crawlspaces. The low profile of the VAPORMAT™ allows for less excavation when compared to placing perforated pipe in gravel.
- When used with Radon-T, allows for a more cost-effective solution as more expensive pipe connection fittings are not required.



INSTALLATION INSTRUCTIONS FOR VAPORMAT™ 080-15 (P/N 66106)

(See pages 5-8 for detailed drawings of VAPORMAT™ Installation.)

1. Roll out the VAPORMAT™ on the sub grade after the final preparation and before the concrete is poured. Typical layout is in the form of a rectangular loops in the largest areas with branches into the smaller areas. However, the actual layout will be dictated based on site specific dimensions and conditions.
2. Position the Radon-T in appropriate location and nail down through the molded in holes with the four (4) 6-inch steel spikes provided in the Radon-T Kit.
3. Lay the VAPORMAT™ over the Radon-T and cut a circular hole in the VAPORMAT™ where the riser pipe will be installed. Secure the VAPORMAT™ to the sub grade using RadonAway® VAPORMAT™ Staples (P/N 66107) or 6-inch steel spikes.
4. Roll out the VAPORMAT™, flatten it as much as possible onto the sub grade, stapling it to the ground as you roll it out. The VAPORMAT™ should be stapled to the ground every 3 to 4 feet, in addition to the splices, corners and “T” junctions.
5. Splices, corners and “T” junctions are connected by overlapping the VAPORMAT™ a minimum of length equal to or greater than the width (i.e., 15 inches). Staple through the upper and lower strips of the VAPORMAT™ strips, using a minimum of four staples at each corner—two to anchor the bottom and two to anchor the bottom layer into the sub grade. It is recommended that vapor barrier tape (RadonAway® P/N 68066 or 68017, or equivalent) be placed over the seam(s).
6. It is recommended that all openings in the fabric at splices, corners and “T” junctions of the VAPORMAT™ be taped (RadonAway® vapor barrier tape — P/N 68066 or 68017, or equivalent); however this is not required where the VAPORMAT™ will be overlain by a vapor barrier.
7. When the structure is ready for the soil gas vent pipe to be installed, the 4-inch plug is removed from the Radon-T and a 4-inch pipe is glued to the Radon-T. If vapor barrier is installed, tape should be used to attach to vertical pipe, then a bed of sealant should be applied around the pipe/barrier joint. This process also is used when VAPORMAT™ is used without vapor barrier.

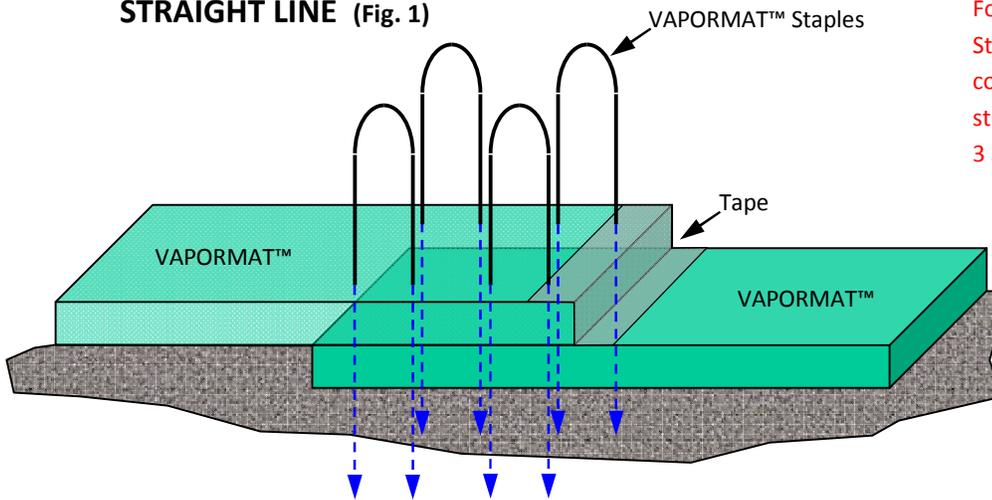


DETAIL: CORNERS, “T” JUNCTIONS AND SPLICES

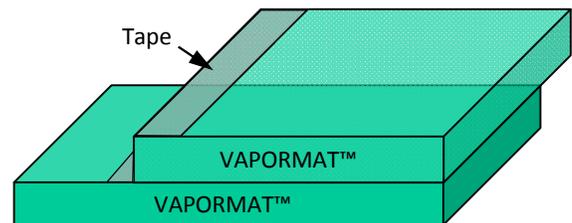
The mat should be routed around the inside perimeter of the foundation. This will require an occasional corner. Furthermore, splices will have to be made to join two lengths of mat together. Corners and splices are very easy to make, and do not require any special fittings. In the case of a splice, merely overlap one section over the other by a distance at least equal or greater than the width of the VAPORMAT™ (i.e., 15 inches) and anchor with four evenly spaced VAPORMAT™ staples (P/N 66107) by pushing through the overlapping VAPORMAT™ and into the subsurface. The seam should also be taped for added security, but is not required when vapor barrier is used over VAPORMAT™. Straight line, “T” junction and corner overlays are illustrated below.

NOTE:
 Four (4) or more VAPORMAT™ Staples should be used at all corners, “T” junctions and straight line splices (Figures 2 and 3 shown without staples)

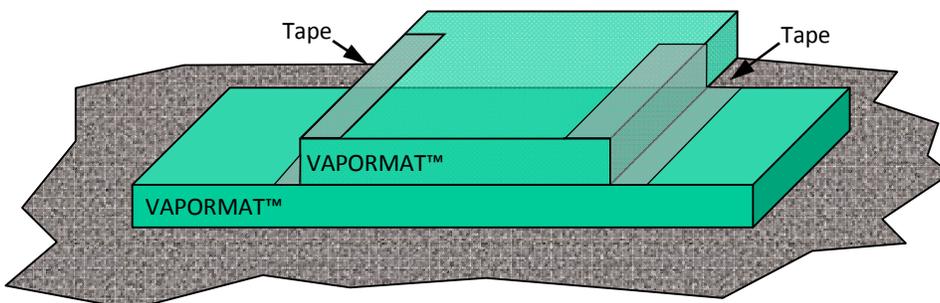
STRAIGHT LINE (Fig. 1)



CORNER (Fig. 3)



“T” JUNCTION (Fig. 2)

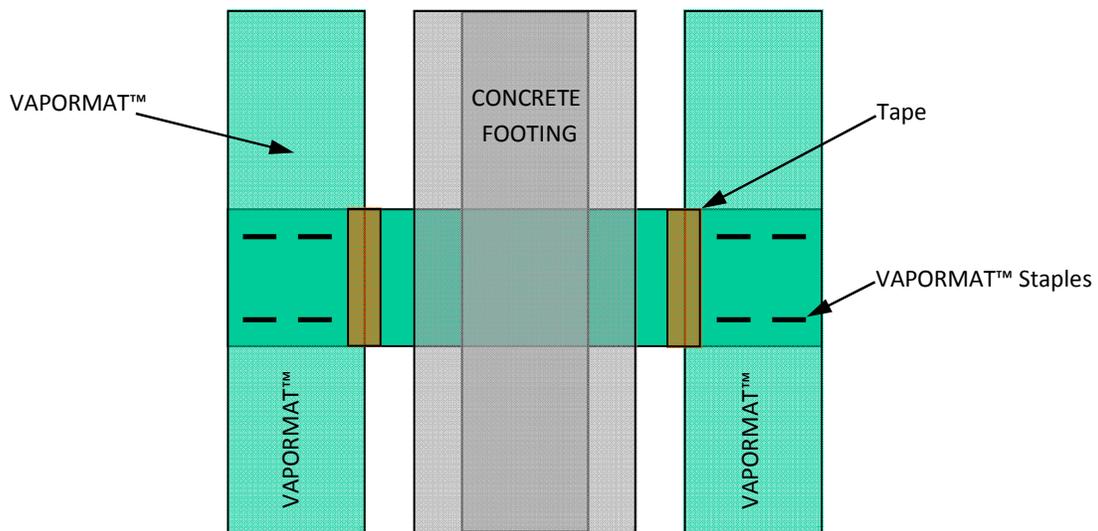




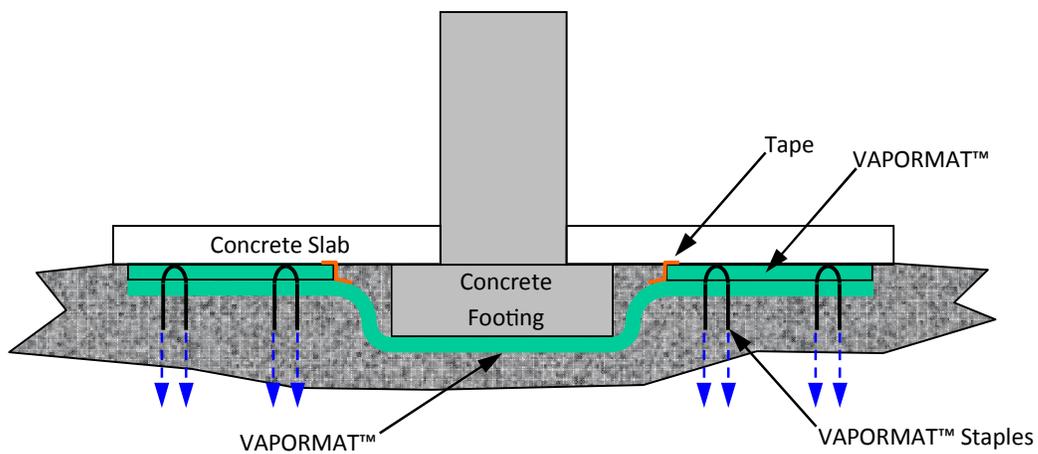
DETAILS: BRIDGING A FOOTING—METHOD 1

There are two methods which can be used to bridge a footing using the VAPORMAT™ , laying the VAPORMAT™ beneath the footing or connecting to a horizontal pipe which cross-sections the footing wall.

METHOD 1: BENEATH FOOTING—OVERHEAD VIEW (Fig. 4)



METHOD 1: BENEATH FOOTING—SIDE VIEW (Fig. 5)

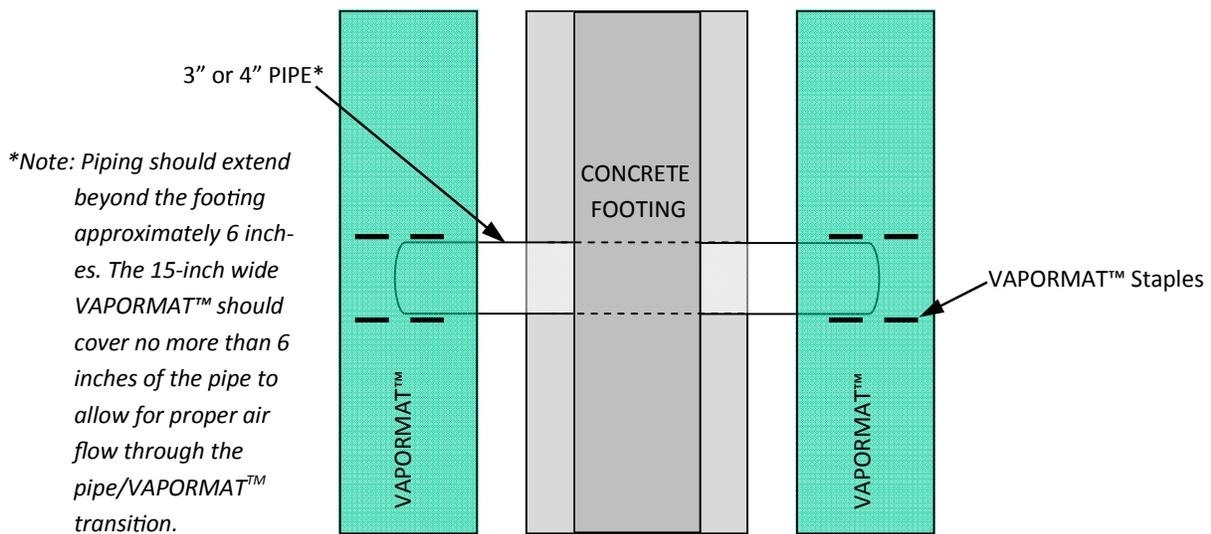




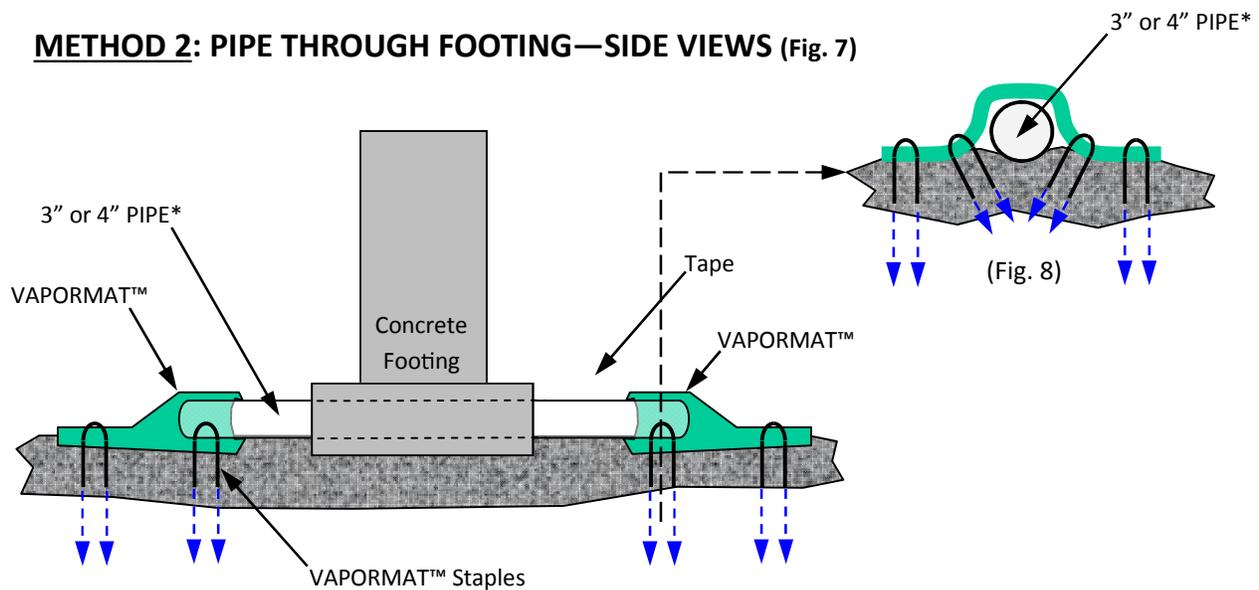
DETAILS: BRIDGING A FOOTING—MTEHOD 2

There are two methods which can be used to bridge a footing using the VAPORMAT™ , laying the VAPORMAT™ beneath the footing or connecting to a horizontal pipe which cross-sects the footing wall.

METHOD 2: PIPE THROUGH FOOTING—OVERHEAD VIEW (Fig. 6)



METHOD 2: PIPE THROUGH FOOTING—SIDE VIEWS (Fig. 7)

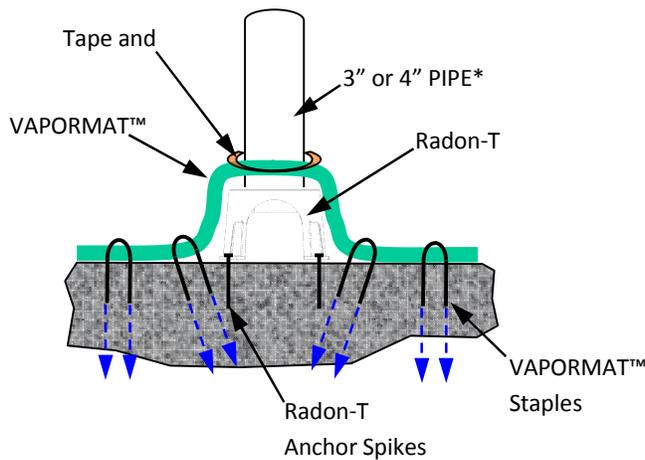




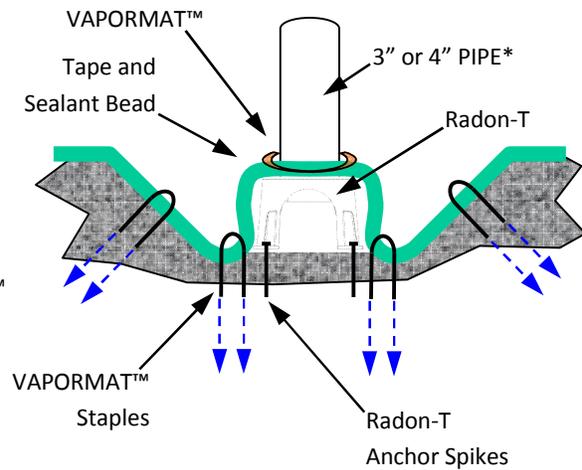
DETAIL: CONNECTING VAPORMAT™ TO RADON-T

The RadonAway® Radon-T replaces ordinary pipe fittings as a base for RRNC and crawlspace systems, the Radon-T saddles over perforated pipe, provides better air flow, prevents blockage by construction debris, and is ideal for use with VAPORMAT™.

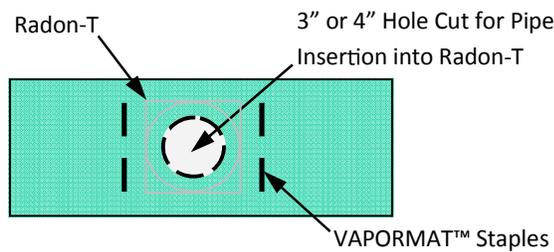
SIDE VIEW (Fig. 9)



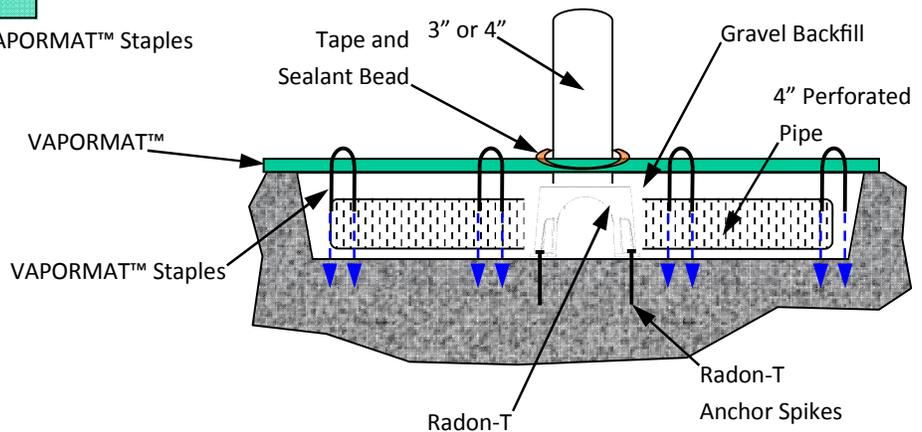
SIDE VIEW—FLUSH TO GRADE (Fig. 10)



OVERHEAD VIEW (Fig. 12)



SIDE VIEW—FLUSH TO GRADE WITH PERFORATED PIPING & STONE (Fig. 11)





DETAILS: POURING CONCRETE OVER VAPOR-MAT™

The filter fabric that is on the top and bottom of the VAPORMAT™ prevents soil, gravel and concrete from entering the material and reducing its air collection capacity. If vapor barrier is not used as an overlayment, care should be taken that the fabric is duct taped closed at splices sufficiently to keep the uncured concrete from entering.

The VAPORMAT™ also needs to be secured to the soil with RadonAway® VAPORMAT™ Staples (P/N 66107) to prevent the concrete from lifting it off the soil while it is being applied. Reinforcing bars and wire can be laid right on top of the VAPORMAT™ or vapor barrier (if present).

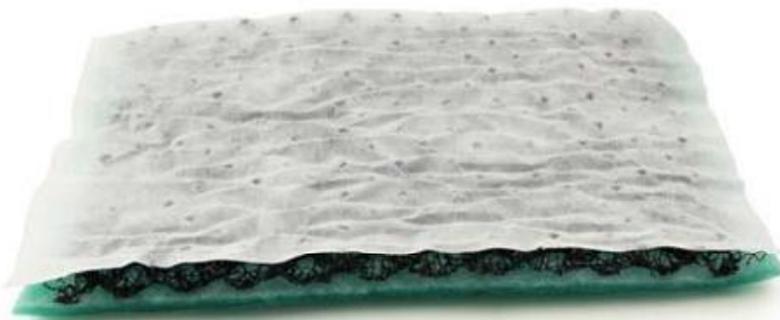


Shown covered with vapor barrier and metal mesh.

VAPORMAT™ is designed to be installed and work in the following conditions:

- Under concrete slab
- Under concrete slab and vapor barrier
- Or in conjunction with sand and/or gravel

VAPORMAT™ has a high compressive strength and performs well under compressive loads exceeding 2500 pounds per square foot; the load of a typical foundation slab is only 30 to 60 pounds per square foot. VAPORMAT™ provides maximum airflow and has an ASTM D 4716 determined flow rate of 11.856 gpm/ft. This high flow rate far exceeds the maximum rate at which ground air can flow through the soil from beneath the slab.





ACCESSORIES:



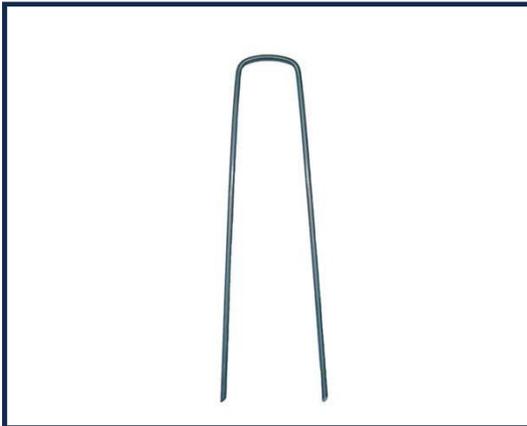
RADONAWAY® RADON-T

P/N 28353

P/N 28354 (Contractor Pack of 12)

Designed and manufactured by RadonAway® to replace ordinary pipe fittings as a base for RRNC and crawlspace systems, the Radon-T stabilizes the vertical pipe, saddles over perforated pipe, provides better air flow, and prevents blockage by construction debris. It is also ideal for use with VAPORMAT™.

Watch a Radon-T installation at radonaway.com/rnc-t



VAPORMAT™ STAPLES

P/N 66107

These 6" x 1", 11 gauge steel staples are made specifically to secure VAPORMAT™ during installation.



TAPE:

P/N 68017 (Black 4" x 108' x 10 mil)

P/N 68066 (White 4" x 180' x 9 mil)

This barrier tape is recommended for use during installation to secure VAPORMAT™ and vapor barrier seams.



VAPORMAT™ 080-15

Radon & Moisture Mitigation Channeling System

VAPORMAT™ 080-15 is a 0.9-inch (23.0 mm) thick, highly adaptable matting system used to collect radon, moisture and other toxic vapors coming from the soil around a house and direct them toward an exhaust stack, which leads them safely out through the roof.

It works effectively as part of a passive soil depressurization system (PSD) or a fan can be added to the exhaust stack for an active soil depressurization system (ASD).

Applications

- ✓ Under slab
- ✓ Under membrane
- ✓ In conjunction with gravel or sand
- ✓ Where a pressure field is required across obstacles or distances

Features and Benefits

Reduces Radon, moisture and other toxic vapor levels in the living space of a home

Reduces the potential for mold and mildew problems

Maintains air flow communication across grade beams, downturns, footers and distant corners

Reduces the need for an exhaust fan or basement humidifier reducing lifetime energy costs

Installation is easy saving time and money over other options

Complies with building codes: IRC Appendix F, RRNC 2.0 and ASTM E-1465

Manufactured in USA

Physical Properties

Description	Means of Measurement		Value	
	English/Metric		English/Metric	
Core Polymer	Polypropylene			
Thickness	Inches	Mm	0.80	20.0
Geotextile Fabric Weight	oz/yd ²	g/m ²	4.5	153
Protection Fabric Weight	oz/yd ²	g/m ²	1.9	64.0

Packaging

Description	Means of Measurement		Value	
	English/Metric		English/Metric	
Core Width	Inches	CM	15.0	38.1
Length	Feet	Meters	45.0	13.7
Roll Diameter	Inches	CM	20.0	50.8



VAPORMAT™ 040-48

Radon & Moisture Mitigation Channeling System

VAPORMAT™ 040-48 is a 0.5-inch (12.5 mm) thick, highly adaptable matting system used to collect radon, moisture and other toxic vapors coming from the soil around a house and direct them toward an exhaust stack, which leads them safely out through the roof.

It works effectively as part of a passive soil depressurization system (PSD) or a fan can be added to the exhaust stack for an active soil depressurization system (ASD).

Applications

- ✓ Under slab
- ✓ Under membrane
- ✓ In conjunction with gravel or sand
- ✓ Where a pressure field is required across obstacles or distances

Features and Benefits

Reduces Radon, moisture and other toxic vapor levels in the living space of a home

Reduces the potential for mold and mildew problems

Maintains air flow communication across grade beams, downturns, footers and distant corners

Reduces the need for an exhaust fan or basement humidifier reducing lifetime energy costs

Installation is easy saving time and money over other options

Complies with building codes: IRC Appendix F, RRNC 2.0 and ASTM E-1465

Manufactured in USA

Physical Properties

Description	Means of Measurement		Value	
	English	Metric	English	Metric
Core Polymer	Polypropylene			
Thickness	Inches	Mm	0.40	10.0
Total Weight	oz/yd ²	g/m ²	22.4	759
Core Weight	oz/yd ²	g/m ²	16.0	543
Geotextile Fabric Weight	oz/yd ²	g/m ²	4.5	153
Protection Fabric Weight	oz/yd ²	g/m ²	1.9	64.0

Packaging

Description	Means of Measurement		Value	
	English	Metric	English	Metric
Core Width	Inches	CM	48.0	122
Length	Feet	Meters	50.0	15.24
Area	Square Feet	Square Meters	200	18.6
Roll Diameter	Pounds	Kg	31.0	14.0

Radon System Stabilizer



Introducing the

Radon-T

Radon system stabilizer for RRNC and Radon Systems from RadonAway, the world's leading radon fan manufacturer.

The right fitting to do the right job.

Specifically engineered as the starting point for new construction and crawlspace radon systems.

Designed to help meet ENERGY STAR® IAP, NAHB, LEED-H and other RRNC and Green Building requirements.

Allows moisture and soil gases to be drawn from under the slab from all angles.

Stands flat and can be staked in place to avoid shaky or crooked pipes.

Eliminates the problem of blocked PVC tees that can hinder soil gas and vapor flow.

Watch a Radon-T installation video at www.RadonAway.com/radon-t



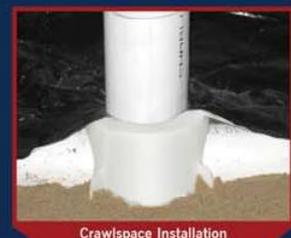
4-Way Airflow with Side Knockouts



New Construction Installation



Easily Saddles Over Drainage Piping



Crawlspace Installation



RadonAway.com/radon-t
800-767-3703

Features

The Radon-T

- *Easily Saddles* over drainage piping
- *Works with* aggregate or geotextile matting
- *Provides 4-way air flow* with side knockouts
- *Accepts 4" schedule 40* into socket
- *Ideal* for new construction and crawlspace mitigations

The Radon-T Kit includes

- **Radon-T** To prepare for installation of an active or passive radon, soil gas and moisture control system.
- **4 Stakes** To stabilize the T in preparation for aggregate fill and slab pour.
- **Vent Pipe Cap** To prevent debris entry and, because it is clearly labeled, avoid the possibility of mistaking the vent pipe stub for a utility pipe "rough in".
- **Instruction Guide** Providing installation and use instructions for Radon-T as well as full RRNC system installation instructions (to assist compliance with ANSI/AARST CCAH-2013, ASTM E1465, IRC Appendix F, and state and local codes where applicable).
- **Set of 4 Labels** To clearly mark Radon/RRNC vent pipes.



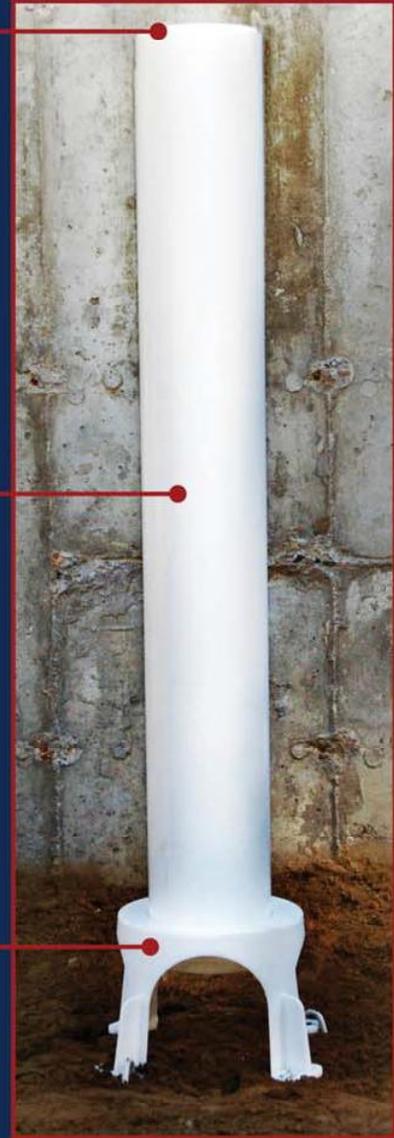
Cap



Pipe provided by builder or installer



Radon-T



The world's leading radon fan manufacturer

RadonAway.com/radon-t

800-767-3703



**RP
PRO SERIES**

INSTALLS WHITE, STAYS WHITE

Radon Mitigation Fan

All RadonAway® fans are specifically designed for radon mitigation. RP Series Fans provide superb performance, run ultra-quiet and are attractive. They are ideal for most sub-slab radon mitigation systems.

Features

- NEW Stay-White™ housing
- Energy efficient
- RP140 - ENERGY STAR Most Efficient 2017
- Ultra-quiet operation
- Meets all electrical code requirements
- Water-hardened motorized impeller
- Seams sealed to inhibit radon leakage (RP140 & RP145 double snap sealed)
- ETL Listed - for indoor or outdoor use
- Thermally protected motor
- Rated for commercial and residential use



MODEL	P/N	FAN DUCT DIAMETER	WATTS	RECOM. MAX. OP. PRESSURE "WC	TYPICAL CFM vs. STATIC PRESSURE WC				
					0"	.5"	1.0"	1.5"	2.0"
RP140	28460	4"	15-21	0.7	135	70	-	-	-
RP145	28461	4"	41-72	1.7	166	126	82	41	3
RP260	28462	6"	47-65	1.3	251	157	70	-	-
RP265	28463	6"	91-129	2.2	334	247	176	116	52
RP380*	28208	8"	95-152	2.0	497	353	220	130	38

Model	A	B	C
RP140	4.5"	9.7"	8.5"
RP145	4.5"	9.7"	8.5"
RP260	6"	11.75"	8.6"
RP265	6"	11.75"	8.6"
RP380	8"	13.41"	10.53"

*Currently not stay-white material.



Made in USA with U.S. and imported parts.



ETL Listed



All RadonAway® inline radon fans are covered by our 5-year, hassle-free warranty.



For Further Information, Contact Your Radon Professional:



SECTION 31 22 13

ROUGH GRADING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Remove topsoil and stockpile for later reuse.
- B. Excavate subsoil and stockpile for later reuse.
- C. Grade and rough contour site to elevations indicated on Drawings.

1.02 RELATED WORK

- A. Section 31 23 00, "Excavation and Fill"
- B. Section 31 23 33, "Piped Utilities - Basic Methods"
- C. Section 31 25 00, "Erosion Control"

1.03 PROJECT RECORD DOCUMENTS

- A. Accurately record location of utilities remaining rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 PROTECTION

- A. Protect trees, shrubs, lawns, and other features remaining as portion of final landscaping.
- B. Protect bench marks, existing structures, roads, sidewalks and paving and curbs.
- C. Protect above or below grade utilities which are to remain.
- D. Repair damage.
- E. Dewatering: All excavation, construction, and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining, and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Architect/Engineer and his/her decision shall be binding upon the Contractor. If the Architect/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Architect/Engineer then agrees with the adequacy of the operating condition.

1.05 DEFINITIONS - The following govern earthwork materials, conditions, and operations.

- A. Stripping: Removal of existing surficial unsuitable materials (see definition) to their entire depth or as directed.
- B. Excavation: Cutting, digging, removing and wasting materials of every description, including soils, foundations, rock and whatever substance encountered to dimensions, limits, elevations and contours as indicated or required by either the Drawings of these Specifications.
- C. Rock: Boulders and detached stones having a volume of 2/3 cubic yards or more and any large masses of igneous, metamorphic, or sedimentary rocks, including firmly conglomerated deposits that cannot be removed with a one cubic yard capacity power shovel without drilling or blasting.
- D. Unsuitable Materials: Topsoil, loam, gumbo, mud, muck, silt, expansive clay, peat, high organic content soils, rubbish, debris, foundation and slab materials, paving materials, rock greater than 3 inches in diameter, vegetation and frozen or dry lumps. Expansive clay is any clay with an expansion potential in excess at 2%.
- E. Unstable Materials: Materials which are not classified as unsuitable materials, but due to their condition of being wet, dry, or frozen are unacceptable for use in fills.
- F. Imported Fill Material or Borrow: Approved soil materials from sources other than those made available by required excavation of project. Unless specifically provided, no imported fill shall be obtained within limits of project site.
- G. Filling/Backfilling: Placing of approved soil materials in accordance with specified procedures and materials and in conformity with lines, grades, contours, cross-sections and elevations shown on Drawings or required by these Specifications.
- H. Subgrade: Undisturbed soil or compacted fill material upon which additional fill stabilized subgrade, sub-base or base course, footing, foundation, or slab cushion is placed.

1.06 QUALIFICATION TESTS

- A. Unless otherwise specified, arrange, supervise, and pay for the following required qualification tests.
- B. Soils Materials: Provide the following information and qualifications tests for each required soils material, including select on-site materials, prior to use on project site.
 - 1. Location of sources for each required imported materials prior to delivery to site.
 - 2. Mechanical analysis, ASTM D422.
 - 3. Liquid limit, ASTM D423 - cohesive materials only.
 - 4. Plastic limit and plasticity index, ASTM 424 - cohesive materials only.
 - 5. Proctor density or relative density information according to test method identified in compaction requirements schedule.

1.07 SUBMITTALS

- A. Comply with requirements of Division 0 and 1. Unless noted otherwise, submit two (2) copies of the following items:
 - 1. Submit material qualification tests and field density test reports directly from testing laboratory.
 - 2. Submit Soils Engineers Certificate of Inspection and Compliance with specified bearing capacity for all footing/foundation subgrades, acceptability of fill area subgrade, and acceptability of select on-site fill materials, if specified for use.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Excavated material, graded free of roots, rocks larger than 1 inch, subsoil, debris, and large weeds.

PART 3 EXECUTION

3.01 GENERAL

- A. The following Specification shall be considered as general criteria for earthwork operations. In those instances where field conditions arise which are not adequately covered by these criteria, instructions for that specific condition will be issued by the Architect/Engineer.
- B. Dust Control:
 - 1. Use all means necessary to control dust on and near the work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site.
 - 2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site.
- C. Grading operations shall be performed in such a manner as to direct and control storm water runoff so that no damage or erosion occurs. Saturation of cut and fill areas shall be prevented by directing storm water runoff and not allowing ponding to occur. Fills are to be crowned as required to maintain drainage at the end of each workday. Existing drainage routes shall not be choked or obstructed until new ones are available. Temporary culverts, pumps or other equipment shall be used to facilitate drainage of fills during construction, failure to drain storm water shall not be grounds for delay of this Contract due to saturated site conditions. The Contractor shall remove and dispose of saturated materials in excess of allowable moisture content at compaction and shall maintain the project schedule at all times.

3.02 ROUGH GRADING AND EMBANKMENT CONSTRUCTION

- A. Rough Grading:
 - 1. Site clearing and grubbing shall be done prior to any rough grading. All debris and deleterious materials shall be removed from areas to be filled or backfilled.
 - 2. Dispose of excess excavated material or supply additional suitable material as necessary to complete the rough grading to the required elevations.

3. The finished subgrade surface shall be reasonably smooth and free from irregular surface changes and shall be no more than one tenth (0.1) of a foot above or below the approved subgrade elevation.
 4. Newly graded areas shall be protected from the action of the elements. Any damage that may occur as a result of natural causes or any construction activities, prior to the acceptance of the work, shall be repaired and grades re-established to the required elevations and slopes.
 5. During the performance of rough grading operations, the subgrade shall be examined critically; and any areas discovered which are soft and unstable or exhibit other unusual conditions, shall be immediately pointed out to the Architect/Engineer. Upon the direction of the Architect/Engineer, these areas shall be excavated to such depths as may be necessary to insure satisfactory supporting properties. These areas of excavation shall be backfilled immediately and shall be brought to the elevation of the surrounding area with unsuitable material in accordance with the embankment construction procedure.
 6. In general, subgrade shall be established at the following levels:
 - a. For Pavement Areas: Finish grade less the thickness of pavement and base material.
 - b. For Structures: Finish floor elevations less the thickness of the slab and any porous fill.
 - c. For Lawn Areas: 4 inches below finished grade.
- B. Compaction and Proof Rolling of Subgrade:
1. All subgrade surfaces shall be proof rolled by means of heavy equipment to locate and permit timely correction of the subgrade deficiencies.
 2. In cut sections, proof rolling of the subgrade surface shall be done to determine the location and extent of areas below subgrade surface that may require subgrade undercutting. Should any portion of the cut subgrade surface fail to provide satisfactory support for the proof rolling operation, the Architect/Engineer may order corrective undercut and backfill work done.
 3. In embankment Sections, prior to placing the embankment, proof rolling on the subgrade surface shall be done to determine the uniformity of the compaction below the subgrade and any deficiencies requiring corrective work. Any deficiencies discovered during proof rolling operations shall be corrected in a manner satisfactory to the Architect/Engineer. After all corrective work has been completed, the surface shall be proof rolled again. Corrective work shall not be considered complete and acceptable until the embankment shows satisfactory and uniform response to the proof rolling operations.
- C. Embankment:
1. After clearing, grubbing, and proof rolling of the existing subgrade has been completed, the surface of the area to be filled shall be scarified to a depth of 4 to 6 inches. An initial 3 inch layer of fill material shall then be spread over the scarified surface and the entire area compacted as specified below.
 2. Each layer of fill material shall be compacted until its density is not less than 95% of the maximum density as determined by the moisture content relationship test ASTM D-698.
 3. Areas requiring fill shall be filled and backfilled using suitable materials compacted in layers not to exceed the following (all thicknesses are loose thicknesses):
 - a. Within building or structure areas - 8 inches.
 - b. Under pavements - 12 inches.
 - c. Under planted areas - 12 inches.

4. The moisture content of placed material shall not deviate from the optimum by more than $\pm 3\%$. Moisture content of any material which displays pronounced deformation under construction equipment shall not exceed the optimum. Drying of wet soil shall be expected by the use of plows, discs, harrows, or other approved methods. If additional water is required, it should be uniformly distributed through the use of approved water wagons and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.
5. The embankment and borrow areas should be maintained in a freely draining condition at all times. Proper drainage should be provided for any water or springs which may be encountered.
6. When the embankment meets the natural grade of a slope, a bench shall be cut in the existing slope. These cuts are to serve as keys to connect the existing grade with the newly placed fill.
7. Frozen fill material nor any suitable fill shall not be placed on frozen or snow-covered surfaces.
8. If soft, yielding material is encountered in embankments as a result of trapping water, and cannot be satisfactorily stabilized by moisture control and compaction, the unstable material shall be excavated to the depth required by the Architect/Engineer. The excavation shall then be filled with suitable material and compacted in accordance with the requirements outlined above.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known below grade utilities. Stake and flag locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass through work area.
- E. Notify utility company to remove and relocate utilities.
- F. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Construction Manager and Architect/Engineer.

3.04 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded and stockpile in area designated on site.
- B. Do not excavate wet topsoil.

3.05 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be re-landscaped or re-graded and stockpile in area designated on site. Excess subsoil is to be placed on site as directed by the Architect.
- B. Do not excavate wet subsoil.

3.06 TOLERANCES

- A. Top of Surface of Subgrade: Plus, or minus 1 inch.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation for building foundations.
- B. Excavation for slabs-on-grade.
- C. Excavation for site structures.
- D. Excavation for paving.

1.02 RELATED SECTIONS

- A. Section 31 23 33, "Piped Utilities - Basic Methods"

1.03 FIELD MEASUREMENTS

- A. Verify that survey benchmark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known underground, above ground, and aerial utilities. Stake and flag locations.
- C. Notify utility company to remove and relocate utilities.
- D. Protect above and below grade utilities which are to remain.
- E. Protect plant life, lawns and other features remaining as a portion of final landscaping.
- F. Protect bench marks, existing structures, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

3.02 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Excavate subsoil required to accommodate building foundations, slabs-on-grade, paving and site structures, and construction operations.

- C. Machine slope banks.
- D. Excavation cut not to interfere with normal 45 degree bearing splay of foundation.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Hand trim excavation. Remove loose matter.
- G. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume.
- H. Notify Construction Manager and Architect/Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- I. Correct unauthorized excavation at no extra cost to Owner.
- J. Correct areas over-excavated by error.

3.03 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Division 1.
- B. Provide for visual inspection of bearing surfaces.

3.04 PROTECTION

- A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation, from freezing.
- C. Dewatering: All excavation, construction and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining, and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Architect/Engineer and his/her decision shall be binding upon the Contractor. If the Architect/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Architect/Engineer then agrees with the adequacy of the operating condition.

END OF SECTION

SECTION 31 23 33

PIPED UTILITIES-BASIC METHODS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Excavate trenches for utilities from 5 feet outside building to municipal utilities or as shown on Drawings.
- B. Compacted bedding for utilities.
- C. Backfilling and compaction.

1.02 RELATED SECTIONS

- A. Section 01 40 00, "Quality Requirements"
- B. Section 31 00 00, "Earthwork"
- C. Section 33 11 00, "Water Distribution"
- D. Section 33 40 00, "Storm Drainage"
- E. Section 33 30 00, "Sanitary Sewerage"
- F. Section 03 30 00, "Cast-in-Place Concrete"

1.03 REFERENCES

- A. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. (2.49 kg) Rammer and 12 inch (3.04.8 mm) Drop.
- C. ANSI/ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- D. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil - Aggregate Mixtures using 10 lb. (4.54 kg.) Rammer and 18 inch (457 mm) Drop.
- E. ANSI/ASTM D2922 - Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
- F. ANSI/ASTM D3017 - Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.04 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Samples: Submit 10 lb. sample to laboratory, in air-tight containers.

- C. Samples shall be submitted to the Testing Agency one (1) week prior to fill placement, in order to complete qualification tests.

1.05 FIELD MEASUREMENTS

- A. Verify that survey benchmark and intended elevations for the Work are as shown on Drawings.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Type A, D, J or K materials as specified in Section 31 00 00, "Earthwork."

2.02 BED MATERIALS

- A. Type B Material: As specified in Type B in Section 31 00 00, "Earthwork."
- B. Type C Material: As specified for Type C in Section 31 00 00, "Earthwork."
- C. Type E Material: As specified for Type E in Section 31 00 00, "Earthwork."
- D. Concrete: Structural concrete conforming to Cast-In-Place Concrete Section with a compressive strength of 1500 psi.

2.03 ACCESSORIES

- A. Geotextile Fabric: Mirafi Geotextile, 160 N or equal for use with underdrain.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify fill materials to be used are acceptable.

3.02 PROTECTION OF PERSONS AND PROPERTY

- A. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.
- B. Earthwork:
 - 1. Stability of temporary excavations:
 - a. All excavations shall be in accordance with OSHA requirements.
 - b. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

- c. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- 2. Shoring:
 - a. Except as specified elsewhere, provide all shoring required for earthwork or required as a result of earthwork for safety of workers, existing structures, public or adjacent properties.
 - b. Provide materials for shoring and bracing in good serviceable condition.
 - c. Establish requirements for shoring and bracing to comply with local codes and authorities having jurisdiction.
 - d. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Maintain and protect existing utilities remaining, which pass through work area. Repair damaged utilities to the satisfaction of the Owner of the utility and the Associate Engineer.
- C. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- D. Protect benchmarks, existing structures, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.
- E. Protect above and below grade utilities which are to remain.

3.04 EXCAVATION

- A. Excavate subsoil and whatever material encountered including rock, required for storm sewers, sanitary sewers, water and gas piping. See rock definition in Earthwork Section.
- B. Cut trenches sufficiently wide to enable installation of utilities and allow inspection and as shown on details provided on Drawings.
- C. Excavations shall not interfere with normal 45 degree bearing splay of foundations.
- D. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- E. Remove lumped subsoil, boulders, and rock greater than 1/3 cu. yd. measured by volume.
- F. Correct unauthorized excavation at no cost to Owner.
- G. Correct areas over-excavated by error in accordance with Earthwork Section at no cost to Owner.
- H. Stockpile excavated material in area designated on site and remove excess material not being used, from site.
- I. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with Type D fill and compact to density equal to or greater than requirements for subsequent backfill materials. Corrective undercut and backfill will be paid for per Earthwork Section, Paragraph 3.04, A.5.

- J. Dewatering: All excavation, construction and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Associate Engineer and his/her decision shall be binding upon the Contractor. If the Associate/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Associate Engineer then agrees with the adequacy of the operating condition.

3.05 BEDDING

- A. Support pipe and conduit during placement and compaction of bedding fill.
- B. Bed per Standard Details provided on Drawings and Schedule at the end of this Section.

3.06 BACKFILLING

- A. Backfill trenches to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Granular Fill: Place and compact materials in continuous layers not exceeding 8 inches compacted depth.
- D. Soil Fill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- E. Employ a placement method that does not disturb or damage conduit in trench.
- F. Maintain optimum moisture content of backfill materials to attain required compaction density.
- G. Leave fill material stockpile areas completely free of excess fill materials.

3.07 TOLERANCES

- A. Top Surface of Backfilling: Under Paved Areas: Plus, or minus 1 inch from required elevations.
- B. Top Surface of General Backfilling: Plus, or minus 1 inch from required elevations.

3.08 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Tests and analysis of fill material will be performed in accordance with ANSI/ASTM D698 / ASTM D1557 and with Division 1.
- C. Compaction testing will be performed in accordance with ASTM D2922 and ASTM D3017 and with Division 1.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to Owner.

E. Frequency of Tests: Every two lifts.

3.09 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Division 1.

B. Recompact fills subjected to vehicular traffic.

3.10 SCHEDULE

A. Storm and Sanitary Piping:

1. Bedding Fill: Type E, per Standard Detail, compacted to 95%.
2. Cover with Type D in 8 inch lifts, compacted to 95%.
3. Under roadways, parking lots, sidewalks, and plaza areas, backfill with Type D in 8 inch lifts compacted to 98%.
4. Under roadways, parking lots, sidewalks, and plaza areas where cover from top of subgrade to top of pipe is less than 48 inches, backfill with Type A or Type J in 8 inch lifts, compacted to 98%.
5. Under roadways, parking lots, sidewalks, and plaza areas where cover from top of subgrade to top of pipe is 30 inches or less, provide concrete encasement per Standard Detail.

B. Waterlines:

1. Bedding Fill: Type A under roadways, parking lots, sidewalks, and plaza areas. Type D in lawn areas.
2. Cover with Type D in 8 inch lifts, compacted to 95%.
3. Under roadways, parking lots, sidewalks and plaza areas, backfill with Type A or Type J in 8 inch lifts, compacted to 100%.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Temporary and permanent erosion and sediment control.
- B. Comply with OEPA requirements and Stormwater Pollution Prevention Plan prepared for this project.

1.02 RELATED WORK

- A. Section 31 00 00, "Earthwork"

1.03 SUBMITTALS

- A. Comply with requirements of Division 0 and 1. Submit material qualification tests and certificates of compliance as indicated.
- B. In accordance with the Stormwater Pollution Prevention Plan (SWPPP) prepared for the project, all stormwater BMPs shall be inspected once every seven (7) days and within 24 hours of a 0.5 inch or greater rainfall. Inspection logs (included herein) shall be kept and shall be submitted to the Owner or Ohio EPA upon request.
- C. At project completion (when all seeding and landscaping is well established), Contractor shall complete and submit to the Ohio EPA the included Notice of Termination (NOT) to terminate coverage from the NPDES General Permit. A copy of the NOT and transmittal shall be provided to the Owner and the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Type F Material - Section 31 00 00, "Earthwork."
- B. Filter Barrier Geotextile: The geotextile shall be of either woven or nonwoven construction and consist of long chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyimide. The filament and fibers shall be oriented into a stable network whereby they retain their positions relative with each other. The geotextile shall be ultraviolet stabilized and shall be inert to chemicals commonly found in soil. The geotextile shall meet or exceed physical properties of Supac 5NPUV or Supac G WMUV.
 - 1. Grab Tensile Strength: 90 lb. minimum as measured per test method ASTM D 1682.
 - 2. Mullen Burst Strength: 190 psi minimum as measured per test method ASTM D 3786.
 - 3. Slurry Flow Rate: 0.3 gal./min./ft² maximum.
 - 4. Equivalent Opening Size: 40-80 as measured per test method US Std. Sieve CW-02215.
 - 5. Ultraviolet Radiation Stability: 70% minimum as measured per test method ASTM D 4355.
- C. Filter Barrier Stakes: 2" x 2" x 3'-0" wooden stakes.

- D. Rock Channel Protection: Quarried stone meeting the requirements of ODOT Item 601.09 Rock Channel Protection, Type A, B, C, or D with filter, as noted on Drawings.
- E. Seed and Soil Supplements for Temporary Seeding: Provide seed mixture with 20% by weight of perennial ryegrass, 30% red fescue and 50% Kentucky Blue Grass. Provide pulverized agricultural limestone and commercial fertilizer, 10-20-20 or approved substitute.
- F. Mulch: Unrotted straw free from weeds and course material or other approved product suitable for required application.
- G. Mulch Binder: Cutback or emulsified asphalt or synthetic binder such as Petroset, Terratack or Aerospray.
- H. Jute Matting: Cloth or Plain weave, undyed and unbleached single jute yarn, 47 to 49 inches wide, averaging 1.15 to 1.26 lbs., per lin. yard loosely twisted construction of not less than 1.6 turns per inch, 78 warp ends per width of cloth and 41 weft ends per lin. yard, meeting the requirements of CC Item 671.
- I. Matting Staples; No. 8 plain wire, 6-10 inches long.
- J. Commercial Matting Products: Erosionet, Holdgro, Weedcheck, Curlex or approved equal. Product must cover minimum of 30% of soil surface and meeting the requirements of CC Item 671 ODOT Item 671.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide temporary and permanent erosion and sediment control items as required by governing agency, as required by permit, as indicated on the plans, as noted in this Specification, and as noted in the Stormwater Pollution Prevention Plan.

3.02 INSTALLATION

- A. Install temporary erosion and sediment control items prior to clearing and commencing earthwork or as soon as practical as sitework progresses.
- B. Install required permanent erosion and sediment control items as soon as no damage or deterioration will result to those items due to construction activities.

3.03 TEMPORARY ACCESS ROAD AND CONTRACTOR USE AREA

- A. Locate access road where indicated or as approved by Owner and local authority having jurisdiction over public roads in vicinity of site. Locate use areas where indicated or as convenient.
- B. Access road shall be at least 20 feet wide. All cuts and fill shall be 3:1 or flatter to the extent possible. Drainage ditches shall be provided as needed. The roadbed and use areas surface shall be cleared of all vegetation, roots, and other objectionable material.

- C. The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with stone, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately.
- D. All roadside ditches, cuts, fills and disturbed areas adjacent to use areas and access road shall be stabilized with appropriate temporary vegetation immediately after grading.
- E. Both road and use areas may require periodic top dressing with new stone. Seeded areas should be checked periodically to ensure that a vigorous stand of vegetation is maintained. Ditches and other drainage structures should be checked regularly to ensure that they do not become clogged with silt or other debris.

3.04 FILTER FABRIC BARRIERS

- A. Construct where indicated or otherwise required by grading operations to reduce sediment content or runoff.
- B. The height of a filter barrier shall be a minimum of 15 inches and shall not exceed 18 inches.
- C. Filter barrier geotextile shall be purchased in a continuous roll and cut to the length of the barrier to avoid the use of joints.
- D. The stakes shall be spaced a maximum of 3 feet apart at the barrier location and driven securely into the ground (minimum of 8 inches).
- E. A trench shall be excavated approximately 4 inches wide and 4 inches deep along the line of stakes and upslope from the barrier.
- F. The filter material shall be stapled to the wooden stakes, and 8 inches of the fabric shall be extended into the trench. Heavy duty wire staples at least 1/2 inch long shall be used. Filter materials shall not be stapled to existing trees.
- G. The trench shall be backfilled, and the soil compacted over the filter material.
- H. If a filter is to be constructed across a ditch line or swale, the barrier shall be of sufficient length to eliminate end flow, and the plan configuration shall resemble an arc or horseshoe with the ends-oriented upslope.
- I. Filter barrier shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.
- J. Filter barrier shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.
- K. Should the fabric on the filter barrier become ineffective prior to the end of its need, the fabric shall be replaced promptly.
- L. Sediment deposits should be removed after each rainfall. They shall be removed when deposits reach approximately one-half the height of the barrier.

- M. Any sediment deposits remaining in place after the silt fence or filter barrier is no longer required shall be dressed to conform with the existing grade, prepared, and seeded.

3.05 ROCK CHANNEL PROTECTION (RCP) PLACEMENT

- A. Place RCP on bedding layer, where indicated, to produce a well graded mass of rock with minimum practical percentage of voids.

3.06 TOPSOIL STORAGE AND APPLICATION

- A. Stockpile acceptable topsoil generally where indicated and in such a manner that natural drainage is not obstructed, and no off-site sediment damage shall result. Side slopes of the stockpile shall not exceed 2:1.
- B. A perimeter dike with gravel outlet, silt fence, or straw bale barrier shall surround all topsoil stockpiles.
- C. Temporary seeding of stockpiles shall be completed within seven (7) days of the formation of the stockpile.
- D. Before topsoiling, establish indicated and needed erosion and sediment control items such as diversions, berms, dikes, waterways, sediment basin, etc. Previously established grades on the areas to be topsoiled shall be maintained according to the Drawings.
- E. After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 2 inches to insure bonding of the topsoil and subsoil.
- F. Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed sodding or seeding. The topsoil shall be uniformly distributed to a minimum compacted depth of 3 inches on 3:1 or steeper slopes and 4 inches on flatter slopes. Any irregularities in the surface, resulting from topsoiling or other operations, shall be corrected in order to prevent the formation of depressions or water pockets. Avoid undue compaction.

3.07 TEMPORARY FILL DIVERSION

- A. The diversion shall be constructed at the top of the fill at the end of each workday as needed.
- B. The diversion shall be located at least 2 feet inside the top edge of the fill.
- C. The supporting ridge of the lower side shall be constructed with a uniform height along its entire length.
- D. Since the practice is temporary and under most situations will be covered the next workday, the maintenance required should be low. If the practice is to remain in use for more than one day, an inspection will be made at the end of each workday and repairs made to the measure if needed. The Contractor should avoid the placement of any material over the structure while it is in use. Construction traffic should not be permitted to cross the diversion.

3.08 TEMPORARY DIVERSION DIKE

- A. Whenever feasible, the dike should be built before construction begins on the project.
- B. The dike should be adequately compacted to prevent failure.
- C. Temporary or permanent seeding and mulch shall be applied to the dike within fifteen (15) days of construction.
- D. The dike should be located to minimize damages by construction operations and traffic.
- E. The measure shall be inspected after every storm and repairs made to the dike, flow channel, and outlet, as necessary. Approximately once every week, whether a storm has occurred or not, the measure shall be inspected, and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

3.09 SEEDING

- A. Incorporate lime and 10-20-20 fertilizer into soil prior to seeding. Apply lime at 900 lbs./1000 S.Y. Apply fertilizer at 200 lbs./1000 S.Y. Apply seed at 25 lbs./1000 S.Y. Within 48 hours after any given area is seeded, straw or hay shall be evenly placed over all seeded areas at the rate of approximately 2 tons per acre for straw, or 3 tons per acre for hay, when seeding is performed between the dates of March 15 and October 15, and the approximate rate of 3 tons per acre straw, or 4 1/2 tons per acre for hay, when seeding is performed between the dates of October 15 and March 15 of the succeeding year. Provide matting where required to establish seed growth.
- B. Areas which fail to establish vegetative cover adequate to prevent rill erosion will be re-seeded as soon as such areas are identified.

3.10 MAINTENANCE

- A. Maintain all erosion and sediment control items until final project acceptance. Repair breaches and replace deteriorated or missing items immediately after discovery.
- B. In accordance with the Stormwater Pollution Plan (SWPPP) prepared for the project, all stormwater BMPs shall be inspected once every seven (7) days and within 24 hours of a 0.5 inch or greater rainfall. Inspection logs (included herein) shall be kept and shall be submitted to the Owner or Ohio EPA upon request.
- C. Clean sedimentation basins and catch basins as required to maintain effectiveness or as otherwise directed.
- D. Removal: Remove temporary erosion control items as directed and prior to Project close-out.

END OF SECTION

CONSTRUCTION POLLUTION PREVENTION PLAN

SITE DESCRIPTION			
Project Name and Location: (Latitude, Longitude, or Address)	Latitude: Longitude:	Owner Name and Address:	
Description: (Purpose and Types of Soil Disturbing Activities)	This project consists of _____.		
Soil disturbing activities will include: <ul style="list-style-type: none"> • Clearing and grubbing • Installing stabilized construction entrance • Perimeter and other erosion and sediment controls • Grading including detention ponds • Storm sewers including detention pond outlet with temporary sediment controls • Construction roads, buildings, etc. • Final preparation including plantings and seeding 			
Runoff Coefficient:	The final coefficient for the area of the site will be C = _____. The existing coefficient is C = _____.		
Site Area:	The site is approximately ____ acres of which approximately ____ acres will be disturbed by construction.		
Sequence of Major Activities (Unless otherwise noted, all activities are the responsibility of the General Contractor.)			
1. Install stabilized construction entrance. 2. Install perimeter erosion control measures where required. 3. Clear and grub. 4. Strip and stock pile topsoil. Seed stock piles. 5. Begin rough grading. 6. Construct detention/sediment basins with outlet protection. 7. Complete rough grading.		8. Install storm sewers and bale inlet filters. 9. Install pavement aggregate base. 10. Construct curb, islands and walks. 11. Complete final paving. 12. Complete fine grading of seeded areas and install permanent seeding and mulching. 13. Remove temporary erosion control measures. Clean sediment from detention basins.	
Name of Receiving Waters:	The area tributary to the site flows into _____ which eventually flows to _____.		

CONTROLS	
Erosion and Sediment Controls	
Stabilization Practices	
<p><u>Area requiring temporary stabilization</u> Any disturbed areas within 50 feet of a stream and not at final grade. For all construction activities, any disturbed areas that will be Dormant for more than 21 days but less than one year, and not Within 50 feet of a stream. Disturbed areas that will be idle over winter.</p>	<p><u>Time frame to apply erosion controls</u> Within two days of the most recent disturbance if the area will Remain idle for more than 21 days. Within seven days of the most recent disturbance within the area. Prior to the onset of winter weather.</p>
<p><u>Temporary Stabilization</u> – Topsoil stock piles will be stabilized with temporary seed and mulch no later than 7 days from the last construction activity in that area. Temporary stabilization must also be applied to any area which will lie idle over the winter. The temporary seed shall be Rye (grass) applied at a rate of 25 lbs. per 1000 S.Y. Prior to seeding, 900 pounds of ground agricultural limestone and 200 pounds of 10-20-20 fertilizer shall be applied to every 1000 S.Y. stabilized. Within 48 hours after any given area is seeded, straw or hay shall be evenly placed over all seeded areas at the rate of approximately 2 tons per acre for straw, or 3 tons per acre straw, or 4-1/2 tons per acre for hay, when seeding is performed between the dates of October 15 and March 15 of the succeeding year. Acres to be paved will be temporarily stabilized by applying stone subbase until bituminous pavement can be applied.</p>	
<p><u>Area requiring permanent stabilization</u> Any areas that will lie dormant for one year or more. Any areas within 50 feet of a stream and at final grade. Any other areas at final grade.</p>	<p><u>Time frame to apply erosion controls</u> Within seven days of the most recent disturbance. Within two days of reaching final grade. Within seven days of reaching final grade within that area.</p>
<p><u>Permanent Stabilization</u> –Permanent seed mix shall consist of 260 lbs/acre of turf Tall Fescue. Prior to seeding, apply commercial fertilizer at the rate of 1 pound actual Nitrogen per 1000 square feet. Fertilizer to have 20:22:14 analysis. After seeding, each area shall be mulched using Turfiber (or equivalent) at a rate of 2000 lbs. per acre with 50 pounds of Turfiber added per 100 gallons of machine capacity. Keep Hydromulch from non-target areas including pavement, plant materials, curbing, and structures. If these surfaces are hit during Hydromulching operations, wash the surface immediately.</p>	
Structural Practices	
<p>Detention Basin: A detention basin will be constructed for this project. It will collect runoff from approximately ___ acres of the project and discharge into _____. The _____ will carry flow to _____.</p>	
Storm Water Management	
<p>When construction is complete, stormwater drainage for the developed areas will be provided by a series of inlets connected by storm sewers that will outlet into the detention basin. Storm water will be released at a controlled rate by the outlet structure. The rate was determined by the Local Authority Having Jurisdiction. The areas disturbed, which are not paved, will be permanently seeded.</p>	
OTHER CONTROLS	
<p>Offsite Vehicle Tracking:</p>	
<p>A stabilized construction entrance will be provided to help reduce vehicle tracking of sediments. The paved road adjacent to the site entrance will be swept daily to remove any excess mud, dirt, or rock tracked from the site. Dump trucks hauling material to or from the construction site will be covered with a tarpaulin.</p>	

TIMING OF CONTROLS/MEASURES
<p>Areas where construction activity temporarily ceases for more than 21 days will be stabilized with a temporary seed and mulch as soon as possible or within 7 days of the last disturbance. Once construction activity ceases permanently in an area, that area will be stabilized within 7 days with permanent seed and mulch. Stripped and stockpiled topsoil should be within 7 days using temporary stabilization seed mix, as described above. After all topsoil has been used the remaining stockpiled topsoil should be seeded using the permanent stabilization method as noted.</p>
CERTIFICATION OF COMPLIANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS
<p>The storm water pollution prevention plan reflects Federal and State Requirements for storm water management and erosion and sediment control. To ensure compliance, this plan was prepared in accordance with the Storm Water Management for Construction Activities published by the EPA.</p>
MAINTENANCE/INSPECTION PROCEDURES
Erosion and Sediment Control Inspection and Maintenance Practices
<p>These are the inspection and maintenance practices that will be used to maintain erosion and sediment controls.</p> <ul style="list-style-type: none"> • All control measures will be inspected at least once each week and following any storm event of 0.5 inches or greater. • All measures will be maintained in good working order, if a repair is necessary, it will be initiated within 24 hours of report. • Built up sediment will be removed from silt fence when it has reached one-third of height of fence. • Silt fence will be inspected for depth of sediment tears, to see if fabric is securely attached to the fence posts and to see that the fence post be firmly in the ground. • Temporary and permanent seeding and planting will be inspected for bare spots, washouts, and healthy growth. • A maintenance inspection report will be made after each inspection. • Personnel selected for inspection and maintenance responsibilities will receive training from the Site Superintendent. They will be trained in all inspection and maintenance practices necessary for keeping the erosion and sediment controls used onsite in good working order.
Non-Storm Water Discharges
<p>It is expected that the following non-storm water discharges will occur from the site during the construction period:</p> <ul style="list-style-type: none"> • Water from water line flushings. • Pavement wash waters (where no spills or leaks of toxic or hazardous materials have occurred). • Uncontaminated groundwater (from dewatering excavation). All dewatering discharges shall be effectively treated prior to release. No turbid discharges are permitted.
INVENTORY FOR POLLUTION PREVENTION PLAN
<p>The materials or substances listed below are expected to be present onsite during construction.</p> <ul style="list-style-type: none"> • Concrete • Detergents • Paints (enamel and latex) • Metal Studs • Concrete • Tar • Fertilizers • Petroleum Based Products • Cleaning Solvents • Wood • Masonry Block

SPILL PREVENTION	
Material Management Practices	
<p>The following are the material management practices that will be used for reducing the risk of spills or other accidental exposure of materials and substances to storm water runoff.</p>	
Good Housekeeping	<p>The following good housekeeping practices will be followed onsite during the construction project:</p> <ul style="list-style-type: none"> • An effort will be made to store only enough product required to do the job. • All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure. • Products will be kept in their original containers with the original manufacturer's label. • Substances will not be mixed with one another unless recommended by the manufacturer. • Whenever possible, all of a product will be used up before disposing of the container. • Manufacturer's recommendations for proper use and disposal will be followed. • The site superintendent will inspect daily to ensure proper use and disposal of materials onsite.
Hazardous Products:	<p>These practices are used to reduce the risks associated with hazardous materials.</p> <ul style="list-style-type: none"> • Products will be kept in original containers unless they are not resealable. • Original labels and material safety data will be retained; they contain important product information. <p>If surplus product must be disposed of, manufacturers or local and State recommended methods for proper disposal will be followed.</p>
Product Specific Practices	
<p>The following product specific practices will be followed onsite:</p>	
Petroleum Products:	<p>All onsite vehicles will be monitored for leaks and receive regular preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers, which are clearly labeled. Any asphaltic substances used onsite will be applied according to the manufacturer's recommendations.</p>
Fertilizers:	<p>Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizers will be transferred to a sealable plastic bin to avoid spills.</p>
Paints:	<p>All containers will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to manufacturer's instructions or State and local regulations.</p>

SPILL PREVENTION (Continued)

Spill Control Practices

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturer's recommended methods of spill cleanup will be clearly posted and site personnel will be aware of the procedures and the location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material will be reported to the appropriate State or local government agency, regardless of size.
- The spill prevention plan will be adjusted to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is another one. A description of the spill, what caused it, and the cleanup measures will also be included.

POLLUTION PREVENTION PLAN CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are sufficient penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Owners Representative

Name (Print): _____

Title: _____

Signature: _____

Date: _____

CONTRACTOR'S CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

Signature	For	Responsible for
Date: _____ Print Name: _____		



Construction Site Inspection Checklist

By making use of some simple Best Management Practices (BMPs) a construction site operator can do his or her share to protect Ohio's water resources from the harmful effects of sediment. The topography of the site and the extent of the construction activities will determine which of these practices are applicable to any given site, but the BMPs listed here are applicable to most construction sites. For details on the installation and maintenance of these BMPs, please refer to *2006 Rainwater and Land Development, Ohio's Standards for Storm Water Management Land Development and Urban Stream Protection* by the Ohio Department of Natural Resources (ODNR) Division of Soil and Water Conservation. The manual is available at <http://www.dnr.state.oh.us/tabid/9186/Default.aspx> or by contacting your county Soil and Water Conservation District.

Temporary Stabilization

This is the most effective BMP. All disturbed areas that will lie dormant for over 21 days must be stabilized within 7 days of the date the area becomes inactive. The goal of temporary stabilization is to provide cover, quickly. Areas within 50 feet of a stream must be stabilized within 2 days of inactivity. This is accomplished by seeding with fast-growing grasses then covering with straw mulch. Apply only mulch between November 1 and March 31. To minimize your costs of temporary stabilization, leave natural cover in place for as long as possible. Only disturb areas you intend to work within the next 21 days.

Construction Entrances

Construction entrances are installed to minimize off-site tracking of sediments. A stone access drive should be installed at every point where vehicles enter or exit the site. Every individual lot should also have its own drive once construction on the lot begins.

Sediment Ponds

Sediment ponds are required for construction areas with concentrated runoff, when the design capacity of silt fence or inlet protection is exceeded, or for drainage areas with 10 or more disturbed areas. There are two types of sediment ponds: sediment basins and sediment traps. A sediment trap is appropriate where the contributing drainage area is 10 acres or less. The outlet is an earthen embankment with a simple stone spillway. A sediment basin is appropriate for drainage areas larger than 10 acres. The outlet is an engineered riser pipe. Often a permanent storm water management pond, such as a retention or detention basin, can be modified to act as a sediment basin during construction. All sediment ponds must be installed within 7 days of first grubbing the area they control, provide a minimum dewatering zone of 67 cubic yards per acre of total contributing drainage area and a sediment settling zone of 34 cubic yards per disturbed acre below the level of the outlet. Sediment basins must be designed to drain the dewatering zone over a 48-hour period.

Silt Fence

This is typically used at the perimeter of a disturbed area. It's only for small drainage areas on relatively flat slopes or around small soil storage piles. Not suitable where runoff is concentrated in a ditch, pipe or through streams. For large drainage areas where flow is concentrated, collect runoff in diversion berms or channels and pass it through a sediment pond prior to discharging it from the site. Combination barriers constructed of silt fence supported by straw bales or silt fence embedded within rock check dams may be effective within small channels. As with all sediment controls, silt fence must be capable of pooling runoff so that sediment can settle out of suspension. Silt fence must be installed within 7 days of first grubbing the area it controls.

Inlet Protection

This must be installed on all yard drains and curb drains when these inlets do not drain to a sediment trap or basin. Even if there is a sediment trap or basin, inlet protection is still recommended, as it will increase the overall sediment removal efficiency. These are best used on roads with little or no traffic. If working properly, inlet protection will cause water to pond. If used on curb inlets, streets will flood temporarily during heavy storms. Check with your municipality before installing curb inlet protection. They may prefer an alternate means of sediment control such as silt fence or ponds.

Permanent Stabilization

All areas at final grade must be permanently stabilized within 7 days of reaching final grade. This is usually accomplished by using seed and mulch, but special measures are sometimes required. This is particularly true in drainage ditches or on steep slopes. These measures include the addition of topsoil, erosion control matting, rock rip-rap or retaining walls. Permanent seeding should be done March 1 to May 31 and August 1 to September 30. Dormant seeding can be done from November 20 to March 15. At all other times of the year, the area should be temporarily stabilized until a permanent seeding can be applied.

Non-Sediment Pollution Control

Although sediment is the pollutant of greatest concern on most construction sites, there are other sources of pollution. Most of these BMPs are easy to implement with a little bit of planning and go a long way toward keeping your site clean and organized. Please be sure to inform all contractors how these BMPs affect their operations on the site, particularly those that will be working near a stream.

Inspection Sheet

INSPECTIONS MUST BE CONDUCTED ONCE EVERY 7 DAYS AND WITHIN 24 HOURS OF A 0.5" OR GREATER RAINFALL. ALL SEDIMENT CONTROLS MUST BE INSTALLED PRIOR TO GRADING AND WITHIN 7 DAYS OF FIRST GRUBBING

GENERAL INSPECTION INFORMATION

Construction Site Inspection Date: _____ Inspector Name: _____

Inspector Title: _____ Qualifications/Certifications: _____

Storm Events of the Last 7 Days

Storm Event Date	Storm Event Time	Storm Event Duration	Total Rainfall Amount	Discharge Occur? (Y/N)
_____	_____	_____	(inches)	_____
_____	_____	_____	(inches)	_____
_____	_____	_____	(inches)	_____
_____	_____	_____	(inches)	_____

Weather Information at the Time of Inspection

Temperature _____ Climate (Sunny, Cloudy, Rain)? _____ Is Storm Water Being Discharged? _____

Sketch or Small Site Map

Along with a narrative inspection log, Ohio EPA recommends the inspector use a sketch or a reduced photocopy of the site plan showing the location of storm water outfalls and storm drain inlets as well as the location and types of control measures. Problems observed at these locations, or at other locations on the construction site, should be highlighted and any corrective measures undertaken should be drawn in and noted in detail on the front side of the sketch. This method will also be helpful as the permittee is required to update the SWP3 to reflect current site conditions.

CONSTRUCTION ENTRANCES

Key things to look for ...

	Yes	No
1. Has the drive been constructed by placing geotextile fabric under the stone?	<input type="checkbox"/>	<input type="checkbox"/>
2. Is the stone 2-inch diameter?	<input type="checkbox"/>	<input type="checkbox"/>
3. Has the stone been placed to a depth of 8 inches, with a width of 10 feet and a length of at least 50 feet (30 feet for entrances onto individual sublots)?	<input type="checkbox"/>	<input type="checkbox"/>
4. If the drive is placed on a slope, has a diversion berm been constructed across the drive to divert runoff away from the street or water resource?	<input type="checkbox"/>	<input type="checkbox"/>
5. If drive is placed across a ditch, was a culvert pipe used to allow runoff to flow across the drive?	<input type="checkbox"/>	<input type="checkbox"/>

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

SEDIMENT PONDS

Key things to look for ...

	Yes	No
1. Are concentrated flows of runoff directed to a sediment pond?	<input type="checkbox"/>	<input type="checkbox"/>
2. Is sheet-flow runoff from drainage areas that exceed the design capacity of silt fence (generally 0.25 acre or larger) directed to a sediment pond?	<input type="checkbox"/>	<input type="checkbox"/>
3. Is runoff being collected and directed to the sediment pond via the storm sewer system or via a network of diversion berms and channels?	<input type="checkbox"/>	<input type="checkbox"/>
4. Is the sediment pond dewatering zone appropriately sized (67 cubic yards per acre of total drainage area)?	<input type="checkbox"/>	<input type="checkbox"/>
5. Is the sediment pond sediment settling zone appropriately sized (34 cubic yards per acre of disturbed area)?	<input type="checkbox"/>	<input type="checkbox"/>
6. Is the sediment basin riser outlet designed so that the dewatering zone will drain in no less time than 48 hours?	<input type="checkbox"/>	<input type="checkbox"/>
7. Have the embankments of the sediment pond and the areas that lie downstream of the pond been stabilized?	<input type="checkbox"/>	<input type="checkbox"/>
8. For sediment basins that dewater 100% between storms, is the riser pipe wrapped with chicken wire and double wrapped with geotextile fabric?	<input type="checkbox"/>	<input type="checkbox"/>
9. Does the riser have 1-inch diameter holes spaced 4 inches apart, both horizontally and vertically?	<input type="checkbox"/>	<input type="checkbox"/>
10. For sediment basins, which dewater 60% between storms, is the diameter of the dewatering hole per plan (see page 105 of <i>Rainwater</i> manual)?	<input type="checkbox"/>	<input type="checkbox"/>
11. For sediment traps, is there geotextile under the stone spillway and is the spillway saddle-shaped?	<input type="checkbox"/>	<input type="checkbox"/>
12. For sediment traps, which dewater 100% between storms, is the dewatering pipe end-capped, no larger than 6 inches in diameter, perforated and double-wrapped in geotextile?	<input type="checkbox"/>	<input type="checkbox"/>
13. Is the length-to-width ratio between inlet(s) and outlet at least 2:1? NOTE: If not, a baffle should be added to lengthen the distance.	<input type="checkbox"/>	<input type="checkbox"/>
14. Is the depth from the bottom of the basin to the top of the primary spillway no more than 3 to 5 feet?	<input type="checkbox"/>	<input type="checkbox"/>
15. For a modified storm water pond being used as a sediment pond, is the connection between the riser pipe and the permanent outlet water-tight?	<input type="checkbox"/>	<input type="checkbox"/>
16. Was the basin installed prior to grading the site?	<input type="checkbox"/>	<input type="checkbox"/>
17. Is it time to clean-out the sediment pond to restore its original capacity? Generally, sediment should be removed once the pond is half-full. Stabilize the dredged sediments with seed and mulch.	<input type="checkbox"/>	<input type="checkbox"/>

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

SILT FENCE

Key things to look for ...

	Yes	No
1. Is the fence at least 4" to 6" into the ground?	<input type="checkbox"/>	<input type="checkbox"/>
2. Is the trench backfilled to prevent runoff from cutting underneath the fence?	<input type="checkbox"/>	<input type="checkbox"/>
3. Is the fence pulled tight so it won't sag when water builds up behind it?	<input type="checkbox"/>	<input type="checkbox"/>
4. Are the ends brought upslope of the rest of the fence so as to prevent runoff from going around the ends?	<input type="checkbox"/>	<input type="checkbox"/>
5. Is the fence placed on a level contour? If not, the fence will only act as a diversion.	<input type="checkbox"/>	<input type="checkbox"/>
6. Have all the gaps and tears in the fence been eliminated.	<input type="checkbox"/>	<input type="checkbox"/>
7. Is the fence controlling an appropriate drainage area? Refer to page 119 of <i>Rainwater</i> manual. RULE OF THUMB: Design capacity for 100 linear feet of silt fence is 0.5 acres for slopes < 2%, 0.25 acres for slopes 2% to 20%, & 0.125 acres for slopes 20% or more. Generally, no more than 0.25 acres should lie behind 100 feet of fence at 2% to 10% slope, i.e., the distance between the fence and the top of the slope behind it should be no more than 125 feet. The allowable distance increases on flatter slopes and decreases for steeper slopes.	<input type="checkbox"/>	<input type="checkbox"/>

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

INLET PROTECTION

Key things to look for ...

	Yes	No
1. Does water pond around the inlet when it rains?	<input type="checkbox"/>	<input type="checkbox"/>
2. Has the fabric been replaced when it develops tears or sags?	<input type="checkbox"/>	<input type="checkbox"/>
3. For curb inlet protection, does the fabric cover the entire grate, including the curb window?	<input type="checkbox"/>	<input type="checkbox"/>
4. For yard inlet protection, does the structure encircle the entire grate?	<input type="checkbox"/>	<input type="checkbox"/>
5. Is the fabric properly entrenched or anchored so that water passes through it and not under it?	<input type="checkbox"/>	<input type="checkbox"/>
6. For yard inlet protection, is the fabric properly supported to withstand the weight of water and prevent sagging? The fabric should be supported by a wood frame with cross braces, or straw bales.	<input type="checkbox"/>	<input type="checkbox"/>
7. Is sediment that has accumulated around the inlet removed on a regular basis?	<input type="checkbox"/>	<input type="checkbox"/>

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

TEMPORARY STABILIZATION

Key things to look for ...

	Yes	No
1. Are there any areas of the site that are disturbed, but will likely lie dormant for over 21 days?	<input type="checkbox"/>	<input type="checkbox"/>
2. Have all dormant, disturbed areas been temporarily stabilized in their entireties?	<input type="checkbox"/>	<input type="checkbox"/>
3. Have disturbed areas outside the silt fence been seeded or mulched?	<input type="checkbox"/>	<input type="checkbox"/>
4. Have soil stockpiles that will sit for over 21 days been stabilized?	<input type="checkbox"/>	<input type="checkbox"/>
5. Has seed and mulch been applied at the proper rate? In general, seed is applied at 3 to 5 lbs per 1000 sq ft and straw mulch is applied at 2-3 bales per 1000 sq ft.	<input type="checkbox"/>	<input type="checkbox"/>
6. Has seed or mulch blown away? If so, repair.	<input type="checkbox"/>	<input type="checkbox"/>

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

PERMANENT STABILIZATION

Key things to look for ...

	Yes	No
1. Are any areas at final grade?	<input type="checkbox"/>	<input type="checkbox"/>
2. Has the soil been properly prepared to accept permanent seeding?	<input type="checkbox"/>	<input type="checkbox"/>
3. Has seed and mulch been applied at the appropriate rate (see page 169 of the <i>Rainwater</i> manual)?	<input type="checkbox"/>	<input type="checkbox"/>
4. If rainfall has been inadequate, are seeded areas being watered?	<input type="checkbox"/>	<input type="checkbox"/>
5. For drainage ditches where flow velocity exceeds 3.5 ft/s from a 10-year, 24-hour storm has matting been applied to the ditch bottom?	<input type="checkbox"/>	<input type="checkbox"/>
6. If the flow velocity exceeds 5.0 ft/s, has the ditch bottom been stabilized with rock rip-rap? NOTE: Rock check dams may be needed to slow the flow of runoff.	<input type="checkbox"/>	<input type="checkbox"/>
7. Has rock rip-rap been placed under all storm water outfall pipes to prevent scouring in the receiving stream or erosion of the receiving channel?	<input type="checkbox"/>	<input type="checkbox"/>
8. For sites with steep slopes or fill areas, is runoff from the top of the site conveyed to the bottom of the slope or fill area in a controlled manner so as not to cause erosion?	<input type="checkbox"/>	<input type="checkbox"/>

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

NON-SEDIMENT POLLUTION CONTROL

Key things to look for ...

- | | Yes | No |
|--|--------------------------|--------------------------|
| 1. Has an area been designated for washing out concrete trucks? Washings must be contained on site within a bermed area until they harden. The washings should never be directed toward a watercourse, ditch or storm drain. | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Is waste and packaging disposed of in a dumpster? Do not burn them on site. | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Are fuel tanks and drums of toxic and hazardous materials stored within a diked area or trailer and away from any watercourse, ditch or storm drain? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Are streets swept as often as necessary to keep them clean and free from sediment? NOTE: Sediment should be swept back onto the lot - not down the storm sewers. | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Are stockpiles of soil or other materials stored away from any watercourse, ditch or storm drain? | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Have stream crossings been constructed entirely of non-erodible material? | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. If an area of the site is being dewatered, is it being pumped from a sump pit or is the discharge directed to a sediment pond? NOTE: if you must lower ground water, the water may be discharged to the receiving stream as long as the water remains clean. Be sure not to co-mingle the clean ground water with sediment-laden water or to discharge it off-site by passing it over disturbed ground. | <input type="checkbox"/> | <input type="checkbox"/> |

Note areas where repairs or maintenance is needed or where this practice needs to be applied:



Division of Surface Water - Notice of Termination (NOT) of Coverage Under Ohio Environmental Protection Agency General NPDES Permit

(Read accompanying instructions carefully before completing this form.)

Submission of this NOT constitutes notice that the party identified in Section II of this form is no longer authorized to discharge into state waters under the NPDES general permit program. NOTE: All necessary information must be provided on this form. Do not use correction fluid on this form. Forms transmitted by fax will not be accepted. There is no fee associated with submitting this form.

I. Permit Information			
NPDES General Permit Number: OH			
Facility General Permit Number:			
II. Owner/Applicant Information/Mailing Address:			
Company (Applicant) Name:			
Mailing (Applicant) Address:			
City:	State:	Zip Code:	
Contact Person:	Phone:	Fax:	
Contact E-mail Address:			
III. Facility/Site Location Information			
Facility Name:			
Facility Address/Location:			
City:	State:	Zip Code:	
County:	Township:	Section:	
Facility Contact Person:	Phone:	Fax:	
Contact E-mail Address:			
IV. Reason for Termination			
Transfer of Ownership <input type="checkbox"/>	Cease to Discharge <input type="checkbox"/>	Facility Closed <input type="checkbox"/>	
Project Completed <input type="checkbox"/>	Obtained Individual Permit <input type="checkbox"/>		
V. Certifications			
Standard Certification:			
<i>I certify under penalty of law that all discharges authorized by the NPDES general permit have been eliminated or that I am no longer the operator of the facility. I understand that by submitting this NOT, I am no longer authorized to discharge under this general permit and that discharging pollutants to waters of the state without an NPDES permit is unlawful under ORC 6111.</i>			
Name (typed):		Title:	
Signature:		Date:	
Industrial Storm Water and Coal Mining Activity Certification Only:			
<i>I certify under penalty of law that all discharges associated with the identified facility that are authorized by the above referenced NPDES general permit have been eliminated, that I am no longer the operator of the facility, or in the case of a coal mine that the SMCRA bond has been released by ODNR-Division of Reclamation. I understand that by submitting this NOT, I am no longer authorized to discharge storm water associated with industrial activity under this general permit, and that discharging pollutants in storm water associated with industrial activity to waters of the state is unlawful under ORC 6111 where the discharge is not authorized by an NPDES permit.</i>			
Name (typed):		Title:	
Signature:		Date:	
Storm Water Construction Activity Certification Only:			
<i>I certify under penalty of law that all elements of the storm water pollution prevention plan have been completed, the disturbed soil at the identified facility have been stabilized and temporary erosion and sediment control measures have been removed at the appropriate time, or that all storm water discharges associated with construction activity from the identified facility that are authorized by the above referenced NPDES general permit have otherwise been eliminated. I understand that, by submitting this NOT, I am no longer authorized to discharge storm water associated with construction activity by the general permit, and that discharging pollutants in storm water associated with construction activity to waters of the state is unlawful under ORC 6111 where the discharge is not authorized by an NPDES permit.</i>			
Name (typed):		Title:	
Signature:		Date:	



Notice of Termination (NOT) Form Instructions For Ohio EPA General Permits

Where to file NOT form

NOTs must be sent to the following address:

Ohio Environmental Protection Agency
General Permit Program
P.O. Box 1049
Columbus, OH 43216-1049

Completing the Form

Please complete the fill-in form on-line at www.epa.ohio.gov/dsw/storm/stormform.aspx or print legibly in the appropriate areas only. Forms transmitted by FAX will not be accepted. Complete all sections of the NOT form. Incomplete forms will be returned to the applicant for resubmittal.

Please place each character slightly above the appropriate line. Abbreviate if necessary to stay within the space allowed for each item.

Section I - Permit Information

Enter the existing Ohio NPDES general permit number assigned to the facility or site for which you are submitting this NOT. If you do not know the permit number, contact the Ohio EPA Storm Water Section at (614) 644-2001.

Section II - Owner/Applicant Information/Mailing Address

This information should appear on the NOT form as it appears on the original Notice of Intent (NOI) form.

Give the legal name of the person, firm, public organization, or any other entity that operates the facility or site described in the application. The name of the operator may or may not be the same as the facility. The operator of the facility is the legal entity which controls the facility's operation rather than the plant or site manager. For construction activities, the responsible party is the owner or the developer of the property. Do not use a colloquial name. Give the name and phone number of a contact person who is responsible for addressing NPDES permit requirements. Enter the complete address and telephone number of the operator (provide phone number as: area code exchange number).

Section III - Facility/Site Location Information

This information should appear on the NOT form as it appears on the original Notice of Intent (NOI) form.

Enter the facility's or site's official or legal name and complete address, including city, state, zip code, county, township, and section. If the facility lacks a street address, indicate the street name and approximate address number.

Section IV - Reason for Termination

Indicate your reason for submitting this NOT by placing an "x" on the appropriate space. You may indicate more than one reason.

Standard Certification

The standard certification should be completed except where a specific certification (listed below) is required.

Industrial Storm Water and Coal Mining Activity Certification Only

This certification should be completed only if you are submitting this NOT to terminate permit coverage under the storm water general permit associated with industrial activity or the general permit associated with coal mining activity.

Construction Certification Only

This certification should be completed only if you are submitting this NOT to terminate permit coverage under the storm water general permit associated with construction activity.

Note for all certifications: provide date as month day year using 2 digits for each space.

Signatory Requirements

Federal statutes provide for severe penalties for submitting false information on this application form. Federal regulations require this application to be signed as follows.

For a corporation: by a responsible corporate officer, which means: (1) a president, secretary, treasurer or vice-president of the corporation in charge of a principal business function or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of one or more manufacturing, production or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

For a partnership or sole proprietorship: by a general partner or the proprietor; or

For a municipality, state, federal, or other public facility: by either a principal executive officer or ranking elected official

SECTION 32 12 00

FLEXIBLE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Asphalt concrete pavement shown on the Drawings and required by the Specifications constructed on a prepared surface in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or otherwise specified.
- B. Coordinate work of other trades who will be working adjacent to paving areas. Coordinate work with Contractor providing compacted base for paving materials.
- C. Inspection and Testing Services required by this Section are to be performed by an Agency retained by the Contractor and approved by the Owner. This includes all field sampling and testing required by the Field Quality Control Section of this Specification.
- D. Related Sections:
 - 1. Section 31 00 00, "Earthwork"
 - 2. Section 31 23 33, "Piped Utilities - Basic Methods"
 - 3. Section 32 13 00, "Rigid Pavement"
 - 4. Section 03 30 00, "Cast-in-Place Concrete"
- E. Do not place asphalt surface course until site work has been completed and construction traffic has been reduced to a minimum.

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. The Asphalt Institute – Manual MS-2 – Mix Design Methods.
 - 2. The Asphalt Institute – Manual MS-4 – The Asphalt Handbook.
 - 3. The Asphalt Institute – Manual MS-13 – Asphalt Surface Treatments and Asphalt Penetration Macadam.
 - 4. ASTM D946 – Asphalt Cement for Use in Pavement Construction.
 - 5. ASTM D1188 – Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Paraffin Coated Specimens.
 - 6. ASTM D2041 – Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - 7. ASTM D2950 – Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
 - 8. State of Ohio, Department of Transportation – Construction and Materials Specifications (CMS) 2019.
- B. Regulatory Requirements:
 - 1. Perform work in accordance with State of Ohio, Department of Transportation Construction and Material Specifications, 2019.
 - 2. Mixing Plant: Conform to State of Ohio, Department of Transportation, Construction and Material Specifications, 2019.

C. Weather Limitations:

1. Place bituminous pavement only when the surface is dry and when weather conditions are such that proper handling, finishing and compaction can be accomplished. In no case, however, shall bituminous pavement be placed when the surface temperature is below the minimum established in the following table:

COURSE THICKNESS	MINIMUM SURFACE TEMPERATURE
1.5 Inches and Over	40°F
1.0 to 1.4 Inches	50°F
Less than 1.0 Inches	60°F

1.03 SUBMITTALS

- A. Submit for approval the mixing plant to be used.
- B. Submit approved job mix formulas for each asphalt concrete pavement prior to preparation of the mixture.
- C. Submit all aggregate and asphalt binder test data, as required.
- D. Submit product data and manufacturer's instructions, including traffic paint.
- E. Submit for approval the name of agency proposed for the required inspection and testing services. All of the required field testing and sampling is to be performed by personnel employed by the proposed agency.
- F. Submit reports of all required testing and inspection.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Surface Course: ODOT Item 441, Asphalt Concrete Surface Course, Type 1, medium or light traffic, PG 64-22.
 1. Refer to drawings and details for extent of medium and light traffic designations.
- B. Intermediate Course: ODOT Item 446, Asphalt Concrete Surface Course, Type 2, medium or light traffic, PG 64-22.
 1. Refer to drawings and details for extent of medium and light traffic designations.
- C. Tack Coat: ODOT Item 407.
- D. Bituminous Aggregate Base Course: ODOT Item 301, Asphalt Concrete Base, PG 64-22.
- E. Aggregate Base Course: ODOT Item 304

2.02 EQUIPMENT

- A. Spreading Equipment: Provide self-contained spreading equipment of sufficient size, power, and stability to receive, distribute, and strike-off the bituminous mixture at rates and widths commensurate with the typical sections and other details shown on the plans. Provide equipment with automatic control systems which maintain the screed in a constant position relative to profile and cross-slope references. These references shall be such that control of the screed position is reasonably independent of irregularities in the underlying surface and of the spreader operation.
- B. Rollers: Provide rollers of the standard steel wheel and pneumatic tire types and meeting the requirements of ODOT Item 401.13.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify compacted subgrade base is dry and ready to support paving and imposed loads.
- B. Proof roll subgrade and correct any areas determined unacceptable to Testing Agency, in accordance with the Agency's recommendations immediately prior to placement of asphalt pavement.
- C. Verify gradients and elevations of base are correct.
- D. Beginning of installation means acceptance of substrate.
- E. Protect existing surfaces and structures adjacent to paving. Repair any damage caused by paving operations at no additional cost to the Owner.

3.02 CONDITIONING EXISTING SURFACE

- A. Immediately prior to the arrival of pavement mixtures, thoroughly clear the pavement base, leveling course, or old pavement of all soil, grass, dirt, or other foreign materials.
- B. When the surface of the existing pavement is irregular, bring to uniform grade as directed using the material specified. Paint contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of bituminous material prior to the bituminous mixture being placed against them.
- C. Where mixture is to be placed against the vertical face of rigid pavement, clean vertical face of foreign material and give an application of bituminous material in a manner which results in a coating of approximately 1/4 gallon per square yard.
- D. Coat surfaces of catch basin frames with oil to prevent bond with asphalt paving.

3.03 PAVEMENT REPAIR

- A. Saw cut perimeter of pavement repair. Extend saw cut fully through the existing surface and asphaltic base material, enabling the removal of the existing failed pavement, leaving a neat and straight edge.
- B. Completely excavate the existing pavement section in areas of repair and remove from the site. Use excavating equipment which shall not damage existing pavement to remain.
- C. In the event that the entire pavement section is removed, proof roll the area. Undercut and replace any existing subbase that is soft and yielding with ODOT Item 304. Remove all unsuitable subgrade material excavated from the pavement repair area from the site. Proof roll in the presence of the Associate / Engineer / Testing Agency. Payment shall be made per contract conditions relative to changes in work. / Payment shall be made on the bases of unit price established.
- D. Where mixture is to be placed against the vertical face of an existing pavement structure, clean the vertical face of foreign material and give an application of tack coat.

3.04 PAVEMENT RESURFACING

- A. Coordinate junction of new and existing pavement. Where new overlay abuts existing pavement, scarify a minimum of 4 feet wide and depth equal to overlay thickness to provide butt joint. Feathering will not be permitted.
- B. Scarify areas around existing structures 4'-0" wide, such that the new overlay will be placed to meeting existing surface level. Scarify other areas of overlay as shown on the Drawings. Maintain positive drainage slopes.
- C. Scarify by milling, grinding or cold planning the existing pavement surface to establish a new surface profile and cross section in preparation for the asphaltic overlay. Provide a surface after grinding that is grooved or ridged finish uniform and resistant to raveling or traffic displacement. Provided a textured surface that has grooves of 0.25 inches in width.
- D. Include grinding around utility castings in the area of the pavement scarified. The At Contractor's option remove the entire existing bituminous pavement around the castings where grinding is not completed and replace it with bituminous surface course placed and compacted in 3 inch lifts. Vertically cut the limits of the area to be patched, mechanically compact the existing base course and prime the bottom and vertical edges before backfilling.
- E. Provide a power operated, self-propelled grinding machine with a cutting drum with lacing patterns that will attain a grooved surface and produce a pressurized watering system for dust control.
- F. Thoroughly clean all areas to be resurfaced. Do not flush cleanup water into the storm sewer system. Remove waste debris cleaned from the site.
- G. Provide asphaltic concrete overlay in areas of resurfacing according to the Drawings and this entire Specification Section, as applicable.

3.05 PREPARATION, MIXING, AND HAULING OF MIXTURE:

- A. Preparation:
 - 1. Bituminous Material Preparation: Heat bituminous material and deliver to the mixer within the temperature range specified in ODOT Item 702. Do not use foaming bituminous materials.
 - 2. Aggregate Preparation: Feed aggregates to the cold elevator in their proper proportions at a rate permitting correct and uniform control of heating and drying. Remove all aggregates in the hot bins that will produce a mix outside the temperature limits or that contain sufficient moisture or expanding gases to cause foaming in the mixture and return to the proper stockpiles.
- B. Mixing:
 - 1. After all of the aggregate is in the mixer, add bituminous material in an evenly spread sheet over the full length of the mixer. The mixing time shall be the time interval between the start of the application of the bituminous material and the opening of the mixer gate. Mix bituminous material for a minimum of 30 seconds. Discharge all bituminous material in no more than 30 seconds.
 - 2. Maintain temperatures of the mixture at the plant in order to be placed at the temperatures specified in Paragraph 3.06.
- C. Hauling:
 - 1. Use trucks for hauling bituminous mixtures that have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of approved material to prevent the mixture from adhering to the beds. Provide each truck a securely fastened, waterproof cover of suitable material to adequately protect the mixture from the wind and weather. Remove covers prior to dumping mixture into the paver.
 - 2. When hot mixtures are being transported at prevailing air temperatures below 50° F or when the length of haul exceeds 20 miles, insulate all truck beds to maintain the specified temperature of the mixture. Do not haul distances in excess of 50 miles unless specifically approved by the Engineer.

3.06 SPREADING

- A. Place tack coat prior to placing surface course or intermediate course per ODOT Item 407.
- B. Spread the pavement mixture on an approved surface with bituminous pavers or spreaders to achieve the specified thickness and compaction. Maximum compacted depth of any one layer shall be as follows:
 - 1. Aggregate Base Course: 8 inches
 - 2. Bituminous Aggregate Base Course: 6 inches
 - 3. Intermediate Course: 3 inches
 - 4. Surface Course: 3 inches
- C. Immediately after the mixture is spread, correct irregularities in grade and alignment by the addition or removal of the mixture before compaction has started.
- D. Remove and replace any areas showing an excess or deficiency of bituminous material before or after compaction.

- E. In areas where irregularities or unavoidable obstacles make the use of mechanical spreading equipment impracticable, spread or rake the mixture with hand tools. For such areas, dump, spread, and screen the mixture to give the specified thickness and compaction.

3.07 COMPACTION

- A. Provide a bituminous mixture with a minimum temperature of 270 degrees F prior to placing in the paver. Immediately after the bituminous mixture has been spread, struck off, and surface irregularities adjusted, thoroughly and uniformly compact by rolling.
- B. Coordinate the spreading of the mixture with the required roller coverage, considering the rate of cooling of the mixture as affected by lift thickness and environmental conditions. Complete final rolling before the pavement reaches a temperature of 180 degrees F.
- C. Along curbs, headers, walls, and in other areas not accessible to rollers, thoroughly compact the mixture with hot, hand tampers or with mechanical tampers.
- D. For all hot bituminous mixtures, provide the number and type of rollers sufficient to compact the mixture at the rate of spreading without exceeding the capacity of the rollers in operation. Compact base, intermediate, and surface courses with a combination of both steel and Type I pneumatic tire rollers, except in small areas which may be compacted by hand tools.
- E. Unless otherwise directed, begin rolling at the outer edges and proceed longitudinally at a slow, uniform speed. After each coverage or complete round trip, progress the roller by overlapping the previous pass by at least half of the width of the roller.
- F. Continue rolling until full coverage of the course has been completed and all roller marks are eliminated.
- G. Replace mixture that becomes loose, broken, contaminated, or otherwise defective with fresh, hot mixture compacted to conform with the surrounding area.
- H. After compaction of the surface course, seal curbs and gutters with asphalt binder. Apply mixture at a uniform width and at a rate just sufficient to fill surface voids.
- I. Do not allow traffic to travel on the compacted pavement until it has cooled sufficiently to prevent glazing.

3.08 JOINTS

- A. Place bituminous paving as continuously as possible. Make longitudinal and transverse joints as a vertical face. Set up joints at the proper height above the adjacent finished pavement to receive maximum compaction.
- B. Provide a well bonded and sealed joint. Coat joint with a 4 inch wide strip of asphalt material along the entire length of the joint.

3.09 TRAFFIC PAINT

- A. Paint all lines, arrows, and other markings in accordance with ODOT Section 640 as required to define parking spaces and traffic flow on pavement as indicated on Drawings. Provide handicapped logos at all handicapped parking spaces.
- B. Paint lines approximately 4 inches wide with even, clean edges and neat, sharp lines.
- C. Apply by highway-type applicator machine in heavy one-coat application in method and coverage recommended by paint manufacturer. Do not hand paint any lines.
- D. Apply traffic paint at the completion of the project when no more construction traffic is expected in the area.

3.10 SPREADING AND SURFACE TOLERANCES

- A. Maintain the rate of spreading within a tolerance of 5 percent of the required calculated weight to achieve proper course depth and compaction.
- B. Do not vary elevation of finished surface course from true elevation by more than 1/4 inch.
- C. Do not vary transverse slope of the surface of the completed course from the specified slope by more than 3/8 inch in 10 feet.
- D. Do not vary transverse slope of the surface of the completed course from the testing edge of a 10 foot straightedge by more than the tolerance specified:
 - 1. Bituminous Aggregate Base course: 3/8 inch.
 - 2. Intermediate course: 1/4 inch.
 - 3. Surface course: 1/4 inch.
- E. Remove and replace portions of the completed pavement that are defective in surface, compression, or composition or otherwise correct in a manner satisfactory to the Engineer.

3.11 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Bituminous Thickness Testing: Provide thickness measurement of field core samples per ASTM D1188 within 48 hours after the pavement is placed. Perform tests as follows:
 - 1. One passing thickness test for each 500 square yards or each lift, whichever is less.
 - 2. Provide random locations of cores or as directed by the Associate / Engineer or Testing Agency. Clearly identify horizontal location at each test core on test reports.
 - 3. Allowable compacted pavement thickness shall be within + 0.25 inches of specified thickness.
 - 4. Fill core holes by the next working day. Before filling, ensure the holes are dry and tack with asphalt material conforming to ODOT Item 407.02. Properly compact the asphalt concrete used to fill the hole leave flush with adjacent pavement.

- C. Bituminous Density Testing: Provide density testing of placed bituminous pavement per ASTM D1188 and ASTM D2950 within 48 hours after the pavement is placed. Theoretical average Maximum Specific Gravity (MSG) shall be determined per ASTM D2041. Perform tests as follows:
1. One passing density test for each 500 sq. or each lift, whichever is less.
 2. Provide random locations of tests or as directed by Associate / Engineer or Testing Agency. Test reports shall clearly identify horizontal location at each test location.
 3. Provide compaction ranging from 90.0 to 97.9 percent of the average Maximum Specific Gravity (MSG) for Surface Course and 90.0 to 96.9 percent for Intermediate Course. Remove and replace any material placed outside of said ranges. Provide replacement pavement and quality assurance testing at no additional cost to the Owner.
 4. Fill core holes by the next working day. Before filling, ensure the holes are dry and tack with asphalt material conforming to ODOT Item 407.02. The asphalt concrete used to fill the hole shall be properly compacted and shall be left flush with adjacent pavement.

3.12 ACCEPTANCE

- A. Asphalt surface not conforming to sections "Spreading and Surface Tolerances" and "Field Quality Control" and/or exhibiting ponding after rain events are subject to rejection and removal and replacement at no cost to the Owner.
- B. When Field Quality Control testing or observations indicate that the Contract requirements have not been met, the Contractor is to bear the costs of any additional testing any analysis to determine acceptability and also the cost of removal and replacement, if such is required.

3.13 PROTECTION

- A. Immediately after placement, protect pavement under provisions of Division 1 from mechanical injury. Maintain clean pavement surface throughout the remainder of the project. Immediately remove any construction debris or soil tracked on new asphalt.
- B. If pavement surface becomes faded or dirty prior to completion of project, clean and seal parking lot prior to applying traffic paint.
- C. Protection of Work by Others: Protect all work by others such manholes, catch basins, sewer cleanouts, lighting posts and bases, sidewalks, etc. Damage to same shall be repaired at the Paving Contractor's expense.

END OF SECTION

SECTION 32 13 00

RIGID PAVEMENT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Concrete sidewalks, detectable warnings, curbs, gutters, and streets.
- B. Reinforcement.
- C. Surface finish.
- D. Curing

1.02 WORK INSTALLED BUT FINISHED UNDER OTHER SECTIONS

- A. Not used.

1.03 RELATED WORK

- A. Section 31 00 00, "Earthwork"
- B. Section 32 12 00, "Flexible Pavement"
- C. Section 33 40 00, "Storm Drainage"
- D. Section 03 30 00, "Cast-in-Place Concrete"

1.04 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings.
- B. ASTM D1751-99 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- C. ASTM D1752-04a – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- D. ASTM C33-03 - Standard Specification for Concrete Aggregates.
- E. ASTM C94-04a - Standard Specification for Ready Mixed Concrete.
- F. ASTM C150-04a - Standard Specification for Portland Cement.
- G. ASTM C260-01 - Standard Specification for Air-Entraining Admixtures for Concrete.
- H. ASTM C309-03 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- I. ASTM C494-04 - Standard Specification for Chemical Admixtures for Concrete.

- J. ASTM C920-02 – Standard Specification for Elastomeric Joint Sealants.
- K. ASTM D5249 – Standard Specification for Backer Material for Use with Cold and Hot Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
- L. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
- M. State of Ohio Department of Transportation Construction and Material Specifications (CMS) 2019.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain materials from same source throughout.
- C. Install curb and gutter in accordance with ODOT Item 609.

1.06 REGULATOR REQUIREMENTS

- A. Conform to City code for paving work on public property.

1.07 TESTS

- A. Testing and analysis will be performed under provisions of Division 1.
- B. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of work.
- C. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

1.08 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Include data on joint filler, admixtures, curing compounds.
- C. Submit manufacturer's instructions under provisions of Division 1.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Cement: ASTM C150-86, Type I, II or III Portland type, gray color.
- B. Fine and Coarse Aggregate: ASTM C33-86.
- C. Water: Potable.

2.02 FORM MATERIALS

- A. Conform to ACI 301.
- B. Joint Filler: ASTM D1751-83.

2.03 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615; 60 ksi yield grade.
- B. Welded Steel Wire Fabric: Plain type, ANSI/ASTM A175; in flat sheets.
- C. Tie Wire: Annealed steel, minimum 16 gauge.
- D. Dowels: ASTM A615; 40 ksi yield grade, plain steel, uncoated finished.
- E. Synthetic Fiber Reinforcement: ASTM C1116-97 and ASTM C1018-97. Acceptable products include, but are not limited:
 - 1. Nycon Nylon Fibers.
 - 2. Forta Nylo-Mono Nylon Fibers
 - 3. Fibermesh Fibermix Stealth Polypropylene Fibers.
 - 4. Grace Polypropylene Fibers
 - 5. Forta Mighty-Mono Polypropylene Fibers

Synthetic fiber reinforcement shall be used in strict accordance with the manufacturer's recommendations. Dosage rate shall be as recommended by the manufacturer, but not less than 1 pound per cubic yard.

2.04 ACCESSORIES

- A. Dissipating Curing Compound: Comply with ASTM C309-98a, Type 1, Class A or B (clear), except moisture loss not to exceed 0.40 kg/sq m. in 72 hours. Compound shall comply with EPA's VOC requirements. Apply at the manufacturer's written recommended application rate.
- B. Sealer: Clear membrane-forming compound which will not yellow. Must be formulated for the intended application, either interior or exterior and applied per the manufacturer's written recommendations. Must comply with EPA's VOC requirements and be compatible with the curing compound used.
- C. Penetrating Sealer: Acceptable products include, but are not limited to:
 - 1. L&M Construction Chemicals - Aquapel Plus 40
 - 2. ProSoCo - Saltguard WB
 - 3. Huls America Inc. - Chem-Trete BSM 40
 - 4. Master Builders Inc. - Masterseal SL 40
 - 5. Lyntal International - Iso-Flex 618-50 WB
 - 6. BASF - Enviroseal 40 or Hydrozo Silane 40
 - 7. Tex-Cote - Rainstopper RS140

- D. Expansion, Isolation, and Construction Joints:
1. Pre-formed Joint Filler: Non-impregnated type, closed cell resilient polyethylene foam, 1/2 inch thick unless otherwise noted. Meet or exceed requirements of ASTM D 1752, Sections 5.1 through 5.4, and ASTM D 5249, Type 2. Ceramar Flexible Foam Expansion Joint by W.R. Meadows or approved equal.
 2. Joint Cap: Two piece vinyl device with upper 1/2 inch removable after curing period. Width corresponding to joint filler. Products by Greenstreak Plastic Products, Vinylex Corp., Vulcan Metal Products, or approved equal.
 3. Joint Sealant: High performance, self leveling, elastomeric polyurethane sealant conforming to ASTM C-920. Sikaflex 1CSL or approved equal.

2.05 ADMIXTURES

- A. Air Entrainment: ASTM C260-86.
- B. Chemical Admixture: ASTM C494-86, Type A or D - water reducing, Type C or E - accelerating.

2.06 CONCRETE MIX

- A. Mix concrete in accordance with ASTM C94.
- B. Provide concrete for the following characteristics:
- Compressive Strength at 28 days: 4000 psi.
 - Min cementitious materials content 564 lbs./cu. yd.
 - Max water-cementitious ratio 0.45, air content 6+1, -1.5%
- C. Use accelerating admixtures in cold weather only when approved by Architect/Engineer. Use of admixtures will not relax cold weather placement requirements.
- D. Use set-retarding admixtures during hot weather only when approved by Architect/Engineer.
- E. Add air entraining agent to concrete mix for concrete work exposed to exterior.
- F. Concrete mixes shall not contain any deleterious or other reactive aggregates or materials that can initiate and promote alkali silica reaction (ASR).

2.07 DETECTABLE WARNINGS

- A. Detectable warning surfaces shall contrast visually with walking surfaces and be textured to provide slip resistance. The preferred color for a light background shall be brick red. The preferred color for a dark background shall be light granite. Color shall be integral with the detectable warning surface and shall not be painted or surface applied.
- B. Detectable warning surface shall have truncated domes with a consistent base diameter ranging from 0.9 inches 1.4 inches. Truncated domes shall have a height of 0.2 inches and a top diameter ranging from 50 to 65 percent of the base diameter.

- C. Truncated domes shall have a consistent spacing ranging from 1.6 inches to 2.4 inches measured center-to-center. Base-to-base spacing measured between the most adjacent domes shall be 0.65 inches minimum.
- D. Detectable warning surfaces shall be of the type specified on the drawings:
 - 1. Type I – Pre-Manufactured Wet-Set Products
 - 2. Type II – Stamped, Color Dyed Concrete
 - 3. Type III – Precast Manufactured Clay and Concrete Pavers
- E. Contractor shall submit detectable warning surface product data for review prior to construction.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify compacted subgrade or granular base stabilized soil is ready to support paving and imposed loads.
- B. Proof roll subgrade and correct any areas determined unacceptable to Testing Agency immediately prior to placement of concrete pavement.
- C. Verify gradients and elevations of base are correct.
- D. Beginning of installation means acceptance of existing conditions.
- E. Proof roll prior to base placement.

3.02 REINFORCEMENT

- A. Place reinforcement at mid-height of slabs-on-grade.
- B. Interrupt reinforcement at expansion joints.
- C. Place reinforcement to achieve slab and curb alignment as detailed.
- D. Provide dowelled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement, per ODOT Item 451.

3.03 JOINTS

- A. Location: Locate as shown on drawings. In absence of information on drawings, provide joints as specified below.
- B. Control Joints: Created within 8 hours of concrete placement. Sawed typical, tooled where allowed by the Engineer.
 - 1. Slabs:
 - a. Spacing (in feet) shall be between 2 to 2-1/2 times slab thickness (in inches) in both directions, i.e. 4-inch thick slab shall have joint spacing at 8 foot to 10 foot centers.

- b. Grid of control joints to be approximately square with longest side to be not longer than 1.5 times the shortest side, i.e. 4-foot wide walk shall have joint spacing at 4 feet to 6 feet maximum.
- c. Depth of Joint: 1/4 of slab thickness.
- d. Width of Joint: 1/8 inch.
- 2. Curbs:
 - a. Maximum 10 feet on center. Aligned with joints in adjacent vehicular paving and sidewalks.
 - b. Depth of Joint: 1-1/2 inches minimum.
 - c. Width of Joint: 1/8 inch.
- C. Isolation Joints: Formed before concrete placement.
 - 1. Location in Slabs and Curbs: Provide where slabs and curbs abut vertical surfaces: at intersections of sidewalks, abrupt changes in slab width, walls, columns, pole bases, outside face or edge of curbs, and manholes, catch basins, or curb inlets.
 - 2. Joint: Provide 1/2 inch wide Pre-formed Joint Filler with removable 3/8 inch deep Joint Caps. Joint Cap shall be set to finish grade elevation. After concrete has set, Joint Cap shall be removed and filled with 3/8 inch of Joint Sealant. Clean joint surfaces free from dirt, dust, and other contaminants that may affect the bond of the joint sealant material. Install Joint Sealant per manufacturer's specifications
 - a. Slabs: Provide Pre-formed Joint Filler to full depth of slab minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
 - b. Curbs: Provide Pre-formed Joint Filler to full depth of curb. Joint Filler material shall be cut to match contour of face of curb minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
- D. Expansion Joints: Formed before concrete placement. Provide when specifically shown on the drawings or when placing concrete during temperatures less than 40 degrees Fahrenheit.
 - 1. Location:
 - a. Slabs: Space maximum of 25 feet on center.
 - b. Curbs: Align with joints in pavement. In absence of concrete pavement, provide at intervals not exceeding 25 feet.
 - 2. Joint: Provide 1/2 inch wide Pre-formed Joint Filler with removable 3/8 inch deep Joint Caps. Joint Cap shall be set to finish grade elevation. After concrete has set, Joint Cap shall be removed and filled with 3/8 inch of Joint Sealant. Clean joint surfaces free from dirt, dust, and other contaminants that may affect the bond of the joint sealant material. Install Joint Sealant per manufacturer's specifications
 - a. Slabs: Provide Pre-formed Joint Filler to full depth of slab minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
 - b. Curbs: Provide Pre-formed Joint Filler to full depth of curb. Joint Filler material shall be cut to match contour of face of curb minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
- E. Construction Joints: Clean, formed joints shall be set at predetermined locations and/or when 30 minutes elapses between successive pours of concrete.
 - 1. Slabs: Provide Pre-formed Joint Filler, Joint Cap, and Joint Sealant at predetermined location. Joint shall be similar to Isolation Joint specified previously.
 - 2. Curbs: Provide Pre-formed Joint Filler, Joint Cap, and Joint Sealant at predetermined location. Joint shall be similar to Isolation Joint specified previously.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301.
- B. Hot Weather Placement: ACI 305.
- C. Cold Weather Placement: ACI 306.
- D. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- E. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- F. Excavate, shape and compact subgrade for suitable bearing surface. Remove unacceptable material. Remove all roots occurring within 12 inches of nearest concrete surface. Fill depressions with acceptable material and compact.
- G. Place, shape, and compact aggregate base to required section and grade. Provide 4 inch base course unless indicated otherwise.
- H. Provide suitable forms of metal, wood or as approved to contain concrete to indicated line, grade and shape until set. Provide face forms for curb and other sections free of defects and conforming to indicated shapes. Provide side forms to full depth of concrete. Use approved flexible forms or curved forms of proper radius on curves having a radius of 150 feet or less.
- I. Coat all forms with form treating material prior to placing concrete to prevent concrete damage during form removal.
- J. Concrete mixing: ACI 301, Chapter 7, ready-mixed unless permission is given to site mix.
- K. Place control, isolation, and expansion joints as indicated on Drawings and as specified previously.
- L. Immediately before concrete placement, thoroughly wet all moisture absorbing material that will be in contact with the concrete. Standing water not permitted.
- M. Place concrete in forms without segregation. Vibrate or hand tamp to remove voids. Strike off concrete and float smooth.
- N. Do not place concrete on frozen ground.
- O. Finish concrete as specified.
- P. Place backfill using required material as soon as possible without damaging concrete.
- Q. Repair or remove and replace damaged concrete as directed. Conform to ACI 301, Chapter 9.

- R. Curing:
 - 1. ACI 301, Chapter 12. Use waterproof sheet materials or liquid membrane.
 - 2. Surfaces which are to receive penetrating sealer are to be moist-cured without the use of a curing compound.
 - 3. Dissipating curing compound may be used, if completely removed prior to application of penetrating sealer.
- S. Place expansion joints as indicated on Drawings. In addition, place where concrete surrounds or adjoins any existing fixed objects such as fire hydrants, columns, building foundations, and other rigid structures.
- T. Maximum allowable deviation of formed edges from indicated location: 1/2 inch. Maximum allowable deviation of surface: 1/8 inch when checked with a 10 foot straight edge. Remove to nearest joint and replace any walk or slab exceeding stated deviations.
- U. Slope walks and slabs away from buildings as indicated but not less than 1/8 inch per foot. Maintain design drainage grades to avoid low spots trapping water.
- V. After water sheen has disappeared, lightly brush surface to a uniform texture unless otherwise indicated or directed. Edge joints to provide a smooth border around each panel.
- W. Appearance: Take special precautions in material sources, mixing, delivery, and placement of walks to insure uniform appearance and coloration throughout the entire walkway. Variations in coloration, texture, and finish of any given type of walkway will be unacceptable.
- X. Do not remove forms for minimum of 12 hours after finishing.

3.05 FINISHING

- A. Sidewalk Paving: Light broom, radiused and trowel joint edges.
- B. Curbs and Gutters: Light broom.
- C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.06 PENETRATING SEALER

- A. Remove all dust, dirt, laitance, and other contaminants. Remove curing compound completely, if used.
- B. Provide test patches as required to ensure compatibility and effectiveness.
- C. Apply with spray or roller, at the manufacturer's written recommended coverage rate, to the following surfaces:
 - 1. Horizontal top surface of all concrete exposed to the weather.
 - 2. Vertical surfaces of columns, walls, curbs, etc. within 12 inches of a treated horizontal surface.
- D. Entire application is to be in strict conformance with the manufacturer's written requirements.

3.07 DETECTABLE WARNINGS

- A. Detectable warning surface shall extend the full width of travel of the curb ramp or landing. Warning surface shall extend a minimum of 24 inches in the direction of travel.
- B. The detectable warning surface shall be located such that the edge of the detectable warning nearest the curb line is 6 inches from the face of curb.
- C. Truncated domes shall be aligned in a square grid and must not be skewed diagonally in the direction of travel. Truncated domes shall be aligned in rows parallel and perpendicular to the direction of travel.
- D. The detectable warning finish surface shall be uniformly profiled to match the adjacent pavement surfaces without lips or obstructions.
- E. Type I and Type II Detectable warning surfaces shall be installed in accordance with the manufacturer's specifications.
- F. Type III Precast Manufactured Clay and Concrete pavers shall be installed per the manufacturer's specifications or as follows:
 - 1. Pavers shall be laid on a 4 inch thick unreinforced concrete base and set into a 1/2 inch thick bed of freshly poured latex or epoxy modified cement mortar.
 - 2. Pavers (excluding dome surface) shall be flush with the surrounding concrete.
 - 3. Joints between pavers and adjacent concrete shall be mortared flush and smooth with the adjacent surface and shall not exceed 1/4 inch in width.
 - 4. Joint spacing between pavers shall be between 1/16 to 5/32 inches.
 - 5. Joints between pavers shall be sand filled. Sand shall be a well graded, washed, non-plastic angular material free from foreign matter. Maximum particle size shall be no larger than the joint spacing.
 - 6. Pavers shall be crack-free and consist of full, completely formed domes.
 - 7. A 6 inch concrete edge restraint shall be provided around the full perimeter of the pavers. Concrete shall be cast-in-place, 3000 psi concrete.
 - 8. Pavers shall be protected during construction to avoid damage. Paver surfaces shall be kept clean of cement.

3.08 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.09 PROTECTION

- A. Immediately after placement, protect concrete under provisions of Division 1 from premature drying, excessive hot or cold temperatures, and mechanical injury.

END OF SECTION

SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Sodding
 - 2. Seeding

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- C. Qualification Data: For landscape Installer.
- D. Material Test Reports: For existing surface soil and imported topsoil.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.
- D. Preinstallation Conference: Conduct conference at Project site upon request by CM.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 SCHEDULING

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Contract Completion.
 - 1. Spring Planting: March 15 until June 15.
 - 2. Fall Planting: August 15 until October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Sodded turf: 60 days from date of Contract Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
- B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water lawn at a minimum rate of 1 inch per week.
- D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 1. Mow grass 3 to 4 inches high.
- E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species, as follows:
 1. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 70 percent turf-type tall fescue.
 - b. 20 percent perennial ryegrass (*Lolium perenne*).
 - c. 10 percent Kentucky bluegrass (*Poa pratensis*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Turf-type tall fescue, a minimum of three cultivars.

2.3 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
 - 1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.5 ORGANIC SOIL AMENDMENTS

- A. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with soil amendments and fertilizers as recommended in the soils report.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply superphosphate fertilizer directly to subgrade before loosening.
 - 2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 3. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.

- C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow lawn seed at the rate of 6 to 8 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at the rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- F. Protect seeded areas from hot, dry weather or drying winds by applying straw mulch within 24 hours after completing seeding operations. Soak and scatter uniformly to a depth of 3/16 inch and roll to a smooth surface.

3.5 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with nonasphaltic tackifier.
 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.
 3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry application at a minimum rate of 500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 lb/acre.

3.7 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.8 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
 - 3. Use installed irrigation system if available.

- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow grass to a height of 3 to 4 inches.
 - 2. Do not mow detention basin.

- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY LAWNS

- A. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

- B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

- C. Remove erosion-control measures after grass establishment period.

END OF SECTION

SECTION 329300

PLANTS

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. Trees.
 - 2. Shrubs.
 - 3. Ground cover.
 - 4. Plants.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.
- D. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of exterior plant required.
- E. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.
- F. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball

shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.

- G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.
- H. Finish Grade: Elevation of finished surface of planting soil.
- I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- J. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.
- K. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- L. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- M. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis for standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- D. Material Test Reports: For existing surface soil and imported topsoil.
- E. Planting Schedule: Indicating anticipated planting dates for exterior plants.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.
- G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for plant growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."
- E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.
- F. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
- G. Plant Substitutions: All substitutions of plant materials must be approved in writing. Enterprise Green Communities (EGC) requires minimum 50% native or adaptive species, and prohibits use of invasive species. Substitution of plant material must include documentation that proposed substitution does not reduce percentage of native or adaptive plant material required for project and that proposed plant material is non-invasive.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver exterior plants freshly dug.
- B. Do not prune trees and shrubs before delivery except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping,

and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery and handling.

- C. Handle planting stock by root ball.
- D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist.
 - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 2. Do not remove container-grown stock from containers before time of planting.
 - 3. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 15 until June 15.
 - 2. Fall Planting: August 15 until October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.
- C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.
 - 1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

- A. Special Warranty: Installer's standard form in which Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Replacement of plant material as part of punchlist inspection does not constitute a warranty replacement.
2. Warranty Periods from Date of Substantial Completion:
 - a. Trees and Shrubs: One year.
 - b. Ground Cover and Plants: One year.
3. Include the following remedial actions as a minimum:
 - a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
 - b. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each exterior plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below.
 1. Maintenance Period: 12 months from date of Substantial Completion.
- B. Initial Maintenance Service for Ground Cover and Plants: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below.
 1. Maintenance Period: Six months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

- A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs of a

larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1.
- D. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.
- E. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

- A. Type 1 Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
 - 1. Provide balled and burlapped trees.
 - 2. Branching Height: One-third to one-half of tree height.
- B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 - 1. Stem Form: Single trunk and/or Multi-trunk clump, as indicated.
 - 2. Provide balled and burlapped trees.
- C. Small Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 - 1. Stem Form: Single trunk, Multi-stem, and/or Clump, as indicated.
 - 2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

- A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
 - 1. Shrub sizes indicated are sizes after pruning.
 - 2. Provide balled and burlapped, balled and potted, and/or container-grown shrubs.

2.4 BROADLEAF EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

- B. Form and Size: Specimen quality as described, symmetrically shaped broadleaf evergreens.

1. Shearing Designation: Semi-sheared or lightly sheared (LS).
2. Provide balled and burlapped, and/or container-grown trees.

2.5 GROUND COVER PLANTS

- A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.6 PLANTS

- A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.
- B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

2.7 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.
 1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2.8 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 1. Provide lime in form of dolomitic limestone.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Perlite: Horticultural perlite, soil amendment grade.

- D. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.9 ORGANIC SOIL AMENDMENTS

- A. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.10 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.11 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Triple-ground, shredded hardwood.

2.12 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

2.13 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with soil amendments and fertilizers as recommended in the soils report.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

3.3 PLANTING BED ESTABLISHMENT

- A. Loosen subgrade of planting beds to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

- a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
2. Spread planting soil mix to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
- B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, restore planting beds if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
 1. Excavate approximately three times as wide as ball diameter for balled and burlapped, and container-grown stock.
 2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
- B. Subsoil removed from excavations may be used as backfill.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
 1. Hardpan Layer: Drill 6-inch diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

3.5 TREE AND SHRUB PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
- B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.

1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- C. Set container-grown stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
1. Carefully remove root ball from container without damaging root ball or plant.
 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- D. Organic Mulching: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 3 inches of trunks or stems.

3.6 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.

3.7 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants as indicated.
- B. Dig holes large enough to allow spreading of roots and backfill with planting soil.
- C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.8 PLANTING BED MULCHING

- A. Mulch backfilled surfaces of planting beds and other areas indicated. Provide mulch ring around trees in lawn areas.
 1. Organic Mulch: Apply 3-inch average thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.9 PLANT MAINTENANCE

- A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

3.10 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.11 DISPOSAL

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 33 11 00

WATER DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provide new water lines from the existing water main to points shown on the plans. This includes, but is not limited to the following:
 - 1. Piping and fittings
 - 2. Fire hydrants
 - 3. Curb boxes and valves
 - 4. Post indicating valves, standard and electrically supervised
 - 5. Post type siamese
 - 6. Tapping sleeves and valves
 - 7. Meter pit and piping
 - 8. Flushing and testing
 - 9. Sterilization
 - 10. All labor, equipment, devices, materials and performing all operations necessary in connection with the combined water system as herein specified and shown, indicated or noted on the drawings and subject to the terms and conditions of the contract.

1.02 RELATED SECTIONS

- A. Section 03 30 00, "Cast-in-Place Concrete"
- B. Section 31 23 33, "Piped Utilities - Basic Methods"

1.03 REFERENCES

- A. American Society of Testing and Materials (ASTM).
 - A377 Specification for Gray Iron and Ductile Iron Pressure Pipe.
 - A47 Specification for Ferritic Malleable Iron Castings.
 - A53 Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc coated welded and seamless.
 - D1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedule 40, 80 and 120.
 - D2774 Underground Installation of Thermoplastic Pressure Piping.
 - D2855 Making Solvent Cement Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.
 - D2241 Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe Systems.
 - D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 - F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - B32 Solder Metal.
 - B88 Seamless Copper Water Tube.

- B. American Water Works Association (AWWA).
 - B300 Hypochlorites.
 - B301 Liquid Chlorine.
 - C104 Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings for Water.
 - C110 Ductile-Iron and Gray-Iron Fittings, 3 inches through 48 inches, for Water and Other Liquids.
 - C111 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 - C115 Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges.
 - C151 Ductile-Iron Pipe. Centrifugal Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - C153 Ductile-Iron Compact Fittings, 3 inches through 12 inches, for Water and Sewage Systems.
 - C502 Dry Barrel Fire Hydrants.
 - C508 Swing-Check Valves for Waterworks Service, 2 inch through 24 inch NPS.
 - C515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
 - C511 Reduced-Pressure Principle Backflow Prevention Assembly.
 - C600 Installation of Grey and Ductile Cast-Iron Water Mains and Appurtenances.
 - C651 Disinfecting Water Mains.
 - C800 Underground Service Line Valves and Fittings.
 - C900 Poly(Vinyl Chloride) (PVC) Pressure Pipe 4 inches through 12 inches for water.
 - M23 PVC Pipe - Design and Installation.
- C. American National Standards Institute (ANSI).
- D. Underwriter's Laboratories (U.L.).
- E. Factory Mutual (FM).
- F. National Sanitation Foundation (NSF).
- G. Plumbing and Drainage Institute (PDI).
- H. National Fire Protection Association (NFPA).
- I. Local Authority Standards / City of Columbus Standards

1.04 REGULATOR REQUIREMENTS

- A. Conform to applicable City code for materials and installation of the Work of this Section.
- B. Contractor to obtain and pay for all required permits, tap fees, inspection fees, etc., as required by Governing Authority.

1.05 CONCRETE WORK

- A. Unless otherwise noted, all cast-in-place concrete shall be by the General Trades Contractor.
- B. Unless otherwise noted, all concrete material and installation shall be as required in Division 3 of the Specifications.

1.06 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Submit product data, shop drawings, catalog cuts, etc., for pipe, fire hydrants, siamese, detector checks, meters, fittings, valves, and accessories.
- C. Certification from the Contractor stating that hydrostatic tests have been conducted in accordance with Specifications and in the presence of the Project Manager Engineer / Inspector and that the completed pipeline is acceptable in accordance with criteria set forth in Specifications for leakage.
- D. Certification from the Contractor stating that pipe lines constructed have been disinfected as specified and are safe for conveying potable water.
- E. Sequence of work in accordance with this Section and Division 1.

1.07 QUALITY ASSURANCE

- A. Conform to applicable governing code for materials and installation of the work of this Section. In the event of a conflict between the drawings and the code, the code shall govern. No extra charges will be allowed for any changes necessary for code compliance.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE (PIPE SIZE 3 INCHES AND LARGER)

- A. Pipe shall conform to ANSI/AWWA C151/A21.51, Class 53, push-on type (buried piping), or to ANSI/AWWA C115/A21.15, flanged type (exposed piping - water vaults, meter pits, etc.). Pipe shall have cement mortar lining per ANSI/AWWA C104/A21.4 inside and asphaltic coating per ANSI/AWWA C151/A21.51 outside.
- B. Fittings shall be ductile iron per ANSI/AWWA C110/A21.10. Fittings shall have cement mortar lining per ANSI/AWWA C104/A21.4 inside and asphaltic coating per ANSI/AWWA C110/A21.10 outside. Fittings 16 inches and smaller may be manufactured according to ANSI/AWWA C153/A21.53. Pressure rating shall be 350 psi minimum.
- C. Joints for exterior buried piping shall be mechanical joint type for fittings and push-on type for pipe, rubber ring gasket type conforming to ANSI/AWWA C111/A21.11.
 - 1. "Tyton Joint Pipe" as manufactured by U.S. Pipe Co.
 - 2. "Super Bell-Tite Joint Pipe" as manufactured by Clow Co.
- D. Joints for exposed piping (meter pits, water vaults, etc.) shall be flanged joints conforming to ANSI/AWWA C115/A21.15 and to ANSI B16.1, 125 lb. template.
- E. All piping and fittings shall be certified by the NSF for use in potable water systems.

2.02 POLYVINYL CHLORIDE (PVC) PIPE 4°INCHES TO 12°INCHES SIZE

- A. Pipe 4 inches to 12 inches shall conform to AWWA C900, Class 200, maximum DR of 14, with elastomeric-gasket type joints.
- B. Fittings shall be cast iron short body style ANSI/AWWA C153/A21.53 / full-body style ANSI/AWWA C110/A21.10 with Mechanical-Joint Ends and plain rubber ring gasket ANSI/AWWA C111/A21.11.
- C. All piping and fittings shall be certified by the NSF for use in potable water systems.

2.03 POLYVINYL CHLORIDE (PVC) PIPE LESS THAN 4°INCHES SIZE

- A. Pipe less than 4 inches size shall conform to ASTM D1785 Schedule 40.
- B. Couplings and fittings shall be PVC Schedule 40.
- C. Joints shall be solvent cement type.
- D. All piping and fittings shall be certified by the NSF for use in potable water systems.

2.04 SEAMLESS COPPER WATER TUBING (LESS THAN 3 INCHES SIZE)

- A. Seamless copper water tubing shall be Type "K" soft temper (buried piping) or Type "L" hard drawn (exposed piping - pits, vaults, etc.), conforming to ASTM B88 with solder (exposed piping) or brazed (buried piping) joints.
- B. Joints shall be 150 psi wrought copper socket solder (ANSI/ASTM B16.22) or brazed (ANSI B31.1) joints.
- C. Solder shall be 95/5 tin-antimony (ASTM B32), lead-free.
 - 1. "Silvabrite 100" as manufactured by Engelhard.
 - 2. "Bridgit" as manufactured by J.W. Harris Co.
- D. Copper Brazing Alloys: Silver/Phosphorous or Silver/Zinc alloys having a melting point greater than 1,000 degrees F. (ANSI B31.1)
 - 1. Sil-Fos filler as manufactured by Handy Harmon.
 - 2. Aircosil filler as manufactured by Airco Welding Products.
- E. Copper/phosphorous or silver/zinc alloys having a melting point greater than 1,350 degrees F.
 - 1. "Stay-Silv 0" as manufactured by J.W. Harris.
 - 2. "FOS-Flo 7" as manufactured by Handy Harmon.
- F. Fittings shall be of the recessed solder joint type (exposed) or brazed (buried) of either wrought copper or cast brass.
- G. Flux shall be non-corrosive.
- H. All piping and fittings shall be certified by the NSF for use in potable water systems.

- I. No alloys containing lead shall be used for brazing or soldering. Contractor shall certify that solder or brazing used for entire new piping system is lead-free.

2.05 VALVES

- A. Gate Valves: 3 Inches and Larger: Resilient wedge, iron body, non-rising stem, UL/FM listed, mechanical joint or flanged ends (flanged ends in valve pits only), working pressure rating 150 psi minimum, renewable bronze yoke bushings, and bronze seat rings; shall conform to AWWA C515. Square operating nut, counter clockwise to open (buried piping) or handwheel operator (valve pits).
 1. American Darling, Clow, Mueller.
- B. Gate Valves: Smaller than 3 Inches: Class 150, solid wedge, non-rising stem (buried piping) or inside screw and rising stem (valve pits), flanged or threaded end connections with a union on one side of the valve. Square operating nut, counter clockwise to open (buried piping) or handwheel operator (valve pits).
- C. Indicator Valves:
 1. Factory assembled UL listed and FM approved PIV, rated at 175 psi minimum, with inside screw grade post indicator-operator. Turn operator counterclockwise to open unless otherwise directed by local fire department. Provide post with a fail-safe feature in case of breaking off above grade to keep valve intact and to move to open position. Furnish worm gear type operator with permanently oil lubricated watertight gear case complete with handle. Bituminous coat all surfaces below grade not less than 12 mils thick. Finish fill, prime and factory finish all above grade surfaces with a multiple coat of high-gloss, weather-resistant, red enamel.
 2. Mueller, Co. Model No. A20806, Kennedy Model No. 2945A and Clow Model No. 2945A.
 3. Electrically supervised. PIV complete with integral tamper switch. Division 16 Contractor to provide control/signal wiring.
- D. Swing Check Valves:
 1. UL/FM listed, 175# WWP cast iron body; brass moving parts including clapper valve seat and pivot shaft, Buna-N "O" ring, flanged connections.
 - a. Viking Model C2, Grinnell, Reliable, or Central.

2.06 VALVE BOXES

- A. Valve boxes shall be cast iron Buffalo type and shall have screw type extension adjustment with flared base. Boxes shall be of sufficient length so that at least 6 inches of adjustment remains when installed to finished grade. The word "water" shall be cast on the cover.
 1. Sigma Corporation, East Jordan Iron Works, Bingham and Taylor, or approved equal.

2.07 TAPPING SLEEVES AND VALVES

- A. Materials and operations shall conform to AWWA C515. Valves shall have one (1) end flanged and other end mechanical joint type with flange for bolting to tapping machine. Sleeves shall be 2-piece cast iron, with mechanical joint ends. Tapping sleeves furnished complete with joint accessories. Valve and sleeve assembly shall be capable of withstanding at least 125 psi work pressure.
 1. Clow Co. Model F5093 valve and F5205 sleeve or approved equal.

2.08 DETECTOR CHECK

- A. UL/FM listed, 175# WWP, cast iron body, two (2) tapped bases for meter and bypass trimming, hard rubber bushings, bronze clapper with full face rubber gasket, neoprene discs, flanged connections. Bronze hinge pins, weights and seat.
- B. Full meter bypass including magnetic drive disc meter with bronze case, globe and check valves.
- C. Hersey Model DC, Grinnell, Reliable, Central, Automatic Sprinkler, or Viking.

2.09 FIRE HYDRANT

- A. Provide fire hydrants per Grove City Fire Department and Water Department standards. If no such standards exist, the following may be used:
 - 1. Dry barrel type, low profile hydrant shall comply with local government requirements and shall be UL listed and FM approved. Hydrant shall have 5 1/4 inch valve opening and two (2) hose outlets and one (1) 4 1/2 inch steamer nozzle complete with non-binding caps and cap chains. Hose outlet threads shall be local fire department.
 - 2. Exterior surface shall be filled, primed, and finished with a multiple coat, high-gloss, weather-resistant red enamel. All surfaces below grade shall receive a coating of bitumen not less than 12 mils thick. Care shall be exercised not to plug barrel drainage outlet applicable provisions of AWWA C502.
 - 3. Mueller Co., Clow, East Jordan Iron Works.

2.10 SIAMESE CONNECTION

- A. Polished brass angle body, post type, two-way 2 1/2 x 2 1/2 x 6 with clappers, 18 inch long polished brass cover sleeve, polished brass I.D. base plate labeled STANDPIPE, plugs and chains with threads to match Local Fire Department.
 - 1. Potter-Roemer, Inc. Fig. 5760 series, Croker-Standard, Elkhart Brass, Guardian, or W.D. Allen.

2.11 DISINFECTION MATERIALS

- A. Liquid chlorine shall conform to AWWA B301. Calcium and sodium hypochlorite shall conform to AWWA B300.

2.12 PRESSURE REDUCING VALVES

- A. 2 Inch and Smaller: All bronze body, stainless steel renewable seats, reinforced Buna-N diaphragm and valve disc (ASSE 1003), dead end service type.
- B. 3 Inch and Larger: Flanged cast iron body dead end service type with bypass tappings, renewable stainless-steel stem and seats, replaceable diaphragm and housing, rubber disc, globe valve, 250 psi WWP with internal parts to be epoxy coated.

2.13 WATER METER

- A. Furnish meter with construction and readout approved by (or furnished by) Grove City.
- B. Remote Readout Register: Hersey Gen-a-reader II measuring in cubic feet per minute.
 - 1. Hersey, Badger or approved equal.

2.14 BACKFLOW PREVENTERS

- A. 175# SWP reduced pressure (ASSE 1013), bronze or cast iron body, with vents, inlet, outlet and valve test cocks, neoprene discs, Buna-N or plastic disc-stainless spring interior check and differential pressure relief valves, 32 degrees F or 145 degrees F meeting the requirements of the local water department.
 - 1. 3/4 Inch to 10 Inches: Watts #909 with air gap air drain funnel. Refer to the Manufacturer's Catalogs for size of drain pipe required.

2.15 CORPORATION STOPS

- A. Ground key type, made of bronze conforming to ASTM B61/B62 and suitable for the working pressure of the system. Ends shall be suitable for solder joint, or flared tube compression type joint.

Threaded ends of inlet and outlet of corporation stops shall conform to AWWA C800, coupling nut for connection to flared copper tubing shall conform to ANSI B16.26.

2.16 YARD HYDRANT

- A. Freezeless/pollution-proof sanitary post type yard hydrant Woodford Model S3 with 1 inch female pipe thread inlet, 3/4 inch brass hose nozzle outlet, PVC drain reservoir and vacuum breaker. Supply line shall be 3/4 inch copper Type K per ASTM B88. Minimum depth of cover 4 feet, unless noted otherwise.

2.17 SPECIALTIES

- A. Tamper Switch:
 - 1. Single Pole, double-throw switch, roller type switch actuator, spring loaded plunger.
 - a. Grinnell Model F640, Reliable, Viking, Central, Star or Automatic Sprinkler.
- B. Pressure Gauge:
 - 1. UL/FM listed, dial spring, brass case, 3 1/2 inches diameter, 1/4 inch NPT male connection, range: 0-300 psig.
 - a. Reliable Model UA, Viking, Grinnell, Central, Star, or Automatic Sprinkler.

PART 3 EXECUTION

3.01 GENERAL CONSTRUCTION REQUIREMENTS

- A. Handling:
1. Utmost care shall be exercised in transporting and handling of pipe, fittings, valves, etc., in order to avoid shock damage to pipe or protective coatings and linings. Pipe, fittings and accessories shall be loaded and unloaded by lifting with hoist or skidding in a manner that will avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. In the event that any part of the coating or lining is damaged, the repair shall be made by the Contractor to the satisfaction of the Engineer or the pipe shall be rejected.
 2. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench without blocking access to driveways, alleys, or public utility facilities.

3.02 PIPING INSTALLATION

- A. Pipe buried in ground shall have firm bearing along entire length of undisturbed earth. Pipe on fill or loose soil shall be supported every 6 feet on brick or concrete piers and then firmly embedded in sand. Provide compacted clay bulkheads to prevent groundwater in sand from draining to building.
- B. Pipe trenches shall be evenly graded.
- C. Depth of bury shall not be less than 4 feet from finished grade to top of pipe barrel. Should there be an apparent significant discrepancy between the ground elevations shown on the drawing and those established in the Contractor's stakeout, the Engineer shall be notified at least ten (10) days ahead of the pipe laying operation. Pipe shall not be laid with depth of bury less than 4 feet without the approval of the Engineer.
- D. Securely anchor each mechanical joint, tee, plug, caps and bends using pipe clamps, tie-rods or concrete thrust blocks conforming to the requirements of NFPA 24 and the authorities having jurisdiction.
- E. All changes in direction shall be made with fittings or joint deflection not exceeding manufacturer's recommendations. Any transition from one (1) pipe size to another shall be made with a reducing fitting. Reducing bushings are prohibited except where specifically called for on the drawings or unless approved by the Engineer.
- F. Pipe cuttings and drilling, where necessary, shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized, cutting shall be done by means of an approved type mechanical cutter. Cut sections of pipe shall be reamed or filed to remove all burrs.

G. Laying:

1. Each section of pipe shall be inspected for defects prior to being lowered into the trench. Defective, damaged or unsound pipe shall not be used.
2. Pipe trenching and bedding foundation shall be provided in accordance with Section 31 23 33, "Piped Utilities." Trenches shall be kept dry during bedding and laying operations. Pipe shall not be laid when the conditions of trench or weather are unsuitable.
3. All pipe shall be carefully lowered into the trench by crane or other method as approved by the Engineer.
4. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipelaying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the preceding pipe. During laying operations, no debris, tools, clothing, or other material shall be placed in the pipe. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth or other substances can enter the pipe or fittings. As work progresses, the interior of the pipe shall be cleaned of any dirt and superfluous materials.
5. After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the bells. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to insure such uniform space. The manufacturer's recommendations as to limits of deflection of joints shall be strictly adhered to. Precautions shall be taken to prevent dirt from entering the joint space.
6. Joints on laid pipe shall not be covered until approved. Pipe, pipe fittings, or appurtenances found defective after installation shall be replaced at the Contractor's expense.

H. Locating:

1. Where location of water pipe is not clearly defined by dimensions of Drawings, water pipe shall not be laid horizontally closer than 10 feet from an active sanitary sewer line except where the bottom of the water pipe will be at least 18 inches above top of the sewer pipe.
2. Where water pipe will cross under active gravity flow sanitary sewer lines, sewer pipe for a distance of at least 10 feet on each side of crossing shall be fully encased in concrete 4 inches thick or shall be made of pressure pipe with no joint located within 3 feet horizontally of the crossing. Joints in sewer pipe closer horizontally of the crossing than 3 feet shall be encased in concrete.
3. Water lines in all cases shall cross above sewage force main or inverted siphons and shall not be less than 18 inches above the sewer main. Sewage force mains or inverted siphon shall be lowered in order to satisfy above requirements and also the minimum cover depth over water line of 4 feet.
4. Water lines shall not be laid in same trench with any gas line, fuel line or electric wiring.

I. Install utility warning tape 18 inches below finished grade.

J. Distribution System Installation.

1. PVC Pipe: Conform to manufacturer's recommendations and AWWA M23 and ASTM D2744.
2. Gate Valves: Install in accordance with AWWA C600 and manufacturer's recommendations.
3. Tapping Sleeves and Valves: The Contractor shall be approved by the authority having jurisdiction for tapping service connection. Install under pressure on lines shown. Valves and sleeves shall be installed in accordance with manufacturer's recommendations. Lines shall be drilled and valves installed using approved equipment as recommended by valve manufacturer. Outages to existing mains during installation, except where approved in cases of emergency, will not be permitted.
4. Valve Boxes: Install in accordance with AWWA C600 over all new below grade valves. Boxes shall be centered over the valves. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box or to the undisturbed trench face if less than 4 feet. A concrete collar shall be placed around each box top at finished grade. Collar shall be 18 inches diameter and 8 inches thick.

K. Thrust Blocks

1. Provide cast-in-place concrete thrust blocks where shown and of the size indicated. The base and thrust bearing sides of block shall be cast directly against undisturbed earth. Sides of thrust blocks not subject to thrust may be cast against forms. The area of bearing shall not be less than that indicated on the drawings. Blocking shall be placed so that the fitting joints will be accessible for repair.
2. Approved joint restraint systems may be used in lieu of thrust blocks.

L. Fire Hydrants

1. Install in accordance with AWWA C600, as applicable except at modified herein.
2. Operating nut shall not be more than 3 feet above the finished grade. Hydrants shall be set so that the bury line marked on the barrel is flush with finished grade. Set hydrants plumb and on a firm footing. Footers shall be provided prior to setting hydrant consisting of either cast-in-place slab or solid concrete block not less than 6 inches thick and 15 inches square. Thrust blocks or restraint rods shall be provided as shown after hydrant has been set in place.
3. Provision shall be taken to carry off drainage from each new hydrant. The area around the base of each new hydrant shall be excavated sufficiently to permit placement of approximately 1/3 cubic yard of 3/4 inch size clean crushed stone to a level several inches above drain opening. The stone shall be placed as shown and covered with roofing paper prior to backfilling to prevent clogging of drain pit.
4. Where ground water is encountered standing at levels above that of hydrants drains the Contractor shall immediately contact the inspector who shall notify the project engineer. Measures will be taken to remedy the situation as directed.
5. Each hydrant and branch line shall be thoroughly flushed, pressure tested and disinfected as specified after thrust blocks and concrete footings have been cured prior to any backfilling.

3.03 QUALITY CONTROL

3.03.1 HYDROSTATIC TESTS

- A. General Requirements:
1. The Contractor shall provide all necessary water, equipment and instrumentation required for proper completion of the flushing and testing of piping systems. Source and quality of water, test procedures and disposal of water shall be approved by the Engineer.
 2. All tests shall be made in the presence of the Local Authority's Inspector. Preliminary tests made by the Contractor without being observed by the Inspector will not be accepted. Notify the Engineer and the Inspector at least twenty-four (24) hours before any work is to be inspected or tested.
 3. All defects in the piping systems shall be repaired and/or replaced and retested until acceptable to the Engineer. Repairs shall be made to the standard of quality specified for the entire system.
 4. Sections of the system may be tested separately, however, any defect which may develop in a section previously tested and accepted shall be promptly corrected and retested. Pressure tests shall be made between valves to demonstrate ability of valve to sustain pressure.
 5. All piping systems shall be tested in accordance with these test methods in addition to any test required by local plumbing codes or building authorities.
- B. Flushing: All piping systems shall be flushed with water to remove construction debris prior to testing. Water for flushing operations shall be paid by the Contractor at the rate set by the authority having jurisdiction.
- C. Hydrostatic Testing:
1. Perform in accordance with AWWA C600 or NFPA 24. Any contradictions between these Specifications and AWWA C600 or NFPA 24, AWWA C600 or NFPA 24 shall govern. Local Code shall govern over these Specifications or AWWA C600 or NFPA 24.
 2. All newly laid pipe, above ground or below ground, or any valved section thereof, shall be subjected to a hydrostatic pressure test as hereinafter tabulated. All piping, that will be considered inaccessible or impossible to repair after the completion of all work, shall be hydrostatically tested while still accessible. Examples of such piping are those near or under basins, lagoons, railroads, paved roads, concrete structures, and concrete foundations.
 3. The Contractor shall backfill all pipe and provide all reaction backing before hydrostatic testing. It shall be the Contractor's responsibility to locate and repair any and all leaks that may develop. The Engineer may direct the Contractor to leave certain joints and connections uncovered until testing has been completed.
 4. Where any section of a main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five (5) days have elapsed after the concrete reaction backing was installed. If high early strength cement is used in the concrete reaction backing, the hydrostatic pressure test shall not be made until at least two (2) days have elapsed.
 5. Reaction backing shall be in accordance with the drawings.
 6. Before applying the specified test pressure, all air shall be expelled from the pipe and the lines shall be thoroughly flushed. If hydrants or blow off valves are not available, taps at points of highest elevation shall be made before the test is made and plugs inserted after the air has been expelled.

7. Each valved section of the pipe shall be slowly filled with water at specified test pressure, based on the elevations of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The Contractor shall make arrangements for metering the amount of water used during the test.
8. The Contractor shall complete testing, backfilling, grading, and cleanup between valved sections as he advances. If the Contractor fails to comply with this provision, pipe laying will be stopped until cleanup is completed.
9. After the section of line to be tested has been filled with water, the specified test pressure shall be applied and maintained for a minimum period of six (6) consecutive hours and for such additional period necessary for the inspector to complete the inspection of the line under test. If defects are noted, repairs shall be made at no additional cost to the Owner and the test repeated until all parts of the line withstand test pressure.
10. Hydrostatic test pressure (gauge) shall be the greater of 1.5 times the working pressure at the point of testing or 150 psi for all pressure piping. Maximum permitted leakage based on 18 foot pipe length is 8 quarts per hour per 100 joints of 12 inches nominal diameter and correspondingly varied for other pressures and sizes of pipe as provided in the AWWA C600 Specification.
11. The pressure shall be maintained within a maximum variation of 5% during the entire leakage test. Leakage measurements shall not be started until the air has been expelled and a constant test pressure has been established.

3.03.2 DISINFECTION

- A. Before acceptance of domestic operation, each unit of completed supply line and distribution system shall be disinfected as specified below or as prescribed by AWWA C651.
- B. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine conforming to AWWA B301 or hypochlorite conforming to AWWA B300. The chlorine material shall provide a dosage of not less than 50 parts per million and shall be introduced into water lines in an approved manner. Treated water shall be retained in pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, retention time shall be at least twenty-four (24) hours and shall produce not less than 10 ppm of chlorine at extreme end of line at end of retention period. All valves on lines being disinfected shall be opened and closed several times during contact period. Lines shall then be flushed with clean water until residual chlorine is reduced to less than 1.0 ppm. Samples of water shall be taken from points in the system in sterilized containers for bacterial examination. Disinfecting shall be repeated until tests indicate absence of pollution for at least two (2) full days. System will not be accepted until satisfactory bacteriological results have been obtained.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary drainage piping, fittings, drop connections, and accessories.
- B. Connection of building sanitary drainage system to municipal sewers.
- C. Manholes.
- D. Permits, inspection fees, tap fees, etc.

1.02 RELATED SECTIONS

- A. Section 31 00 00, "Earthwork"
- B. Section 31 23 33, "Piped Utilities - Basic Methods"
- C. Section 03 30 00, "Cast-in-Place Concrete"

1.03 REFERENCES

- A. ASTM 2321 - Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- B. ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D3212 - Joints for drainage Sewer Plastics Pipes using Flexible Elastomeric Seals.
- D. ANSI/ASTM A74 - Cast Iron Soil Pipe and Fittings.
- E. AWWA C106 - Cast Iron Pressure Pipe.
- F. ASTM C12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- G. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- H. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable municipal code for materials and installation of the Work of this Section. In the event of a conflict between the drawings and the code, the code shall govern. No extra charges will be allowed for any changes necessary for code compliance.
- B. Contractor to obtain and pay for all required permits, tap fees, inspection fees, etc., as required by State and local authority.

1.05 SUBMITTALS

- A. Submit shop drawings under provisions of Division 1.
- B. Submit shop drawings indicating dimensions, and invert elevations of manholes and cleanouts.
- C. Submit product data under provisions of Division 1.
- D. Submit product data for pipe, manholes, castings, and pipe accessories.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Division 1.
- B. Accurately record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities. Provide location, size, and elevation of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Plastic Pipe: ANSI/ASTM D3034, SDR 35 Type PSM, polyvinyl chloride (PVC) material.
- B. Plastic Pipe Joints: ASTM D3212, bell and spigot style, flexible elastomeric seals.
- C. Clay Pipe 4 Inches-24 Inches: ASTM C-700, Vitrified Clay Pipe, Extra Strength.
- D. Clay Pipe Joints: ASTM C-425.
- E. Cast Iron Soil Pipe: ANSI/ASTM A74. Building service lines only.

2.02 PIPE ACCESSORIES

- A. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required "T," bends, elbows, cleanouts, reducers, traps, and other configurations required.

2.03 MANHOLES

- A. Lid and Frame: Cast iron construction, removable lid, closed lid design; nominal lid and frame diameter as shown on plans.
- B. Shaft Construction and Eccentric Cone Top Section: ASTM C478, O-ring joints per ASTM C443 reinforced precast concrete pipe sections, lipped male/female joints; cast ladder rungs into shaft sections at 16 inches, nominal shaft diameter of 48 inches. Cast-in-place concrete side walls may be used in place of precast construction. Cast-in-place side walls shall be 8 inches nominal thickness.

- C. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, "Cast-in-Place Concrete"; leveled top surface to receive sewer pipe Section. Precast base sections may be used in lieu of cast-in-place base.
- D. Resilient connectors between precast manhole and pipes shall conform to ASTM C-923.

2.04 CLEANOUTS

- A. Cleanouts shall be adjustable, vandal-proof with heavy cast iron top for exterior use.
 - 1. Zurn Z-1400-VP as manufactured by Zurn Industries, Inc.
 - 2. Jay R. Smith 4220-U, as manufactured by Jay R. Smith Manufacturing Co.

2.05 BEDDING MATERIAL

- A. Type E as specified in Section 31 00 00, "Earthwork."

2.06 FILL MATERIAL

- A. Type A, D, J or K as specified in Section 31 00 00, "Earthwork."

2.07 VENT PIPING

- A. Pipe: PVC Pipe, Schedule 40 per ASTM D1785.
- B. Fittings: Per ASTM D2466. Connect with solvent cement type per ASTM D2855-93.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut is ready to receive work, and excavations, dimensions, and elevations are as indicated on Drawings.
- B. Beginning of installation means acceptance of existing conditions.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with Type A or Type D fill material.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling and compaction.

3.03 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ANSI/ASTM D2321, and manufacturer's instructions. Seal joints watertight.
- B. Install rigid pipe, fittings, and accessories in accordance with ASTM C-12 and manufacturer's instructions.

- C. Bed pipe with Type E material per standard detail on Drawings.
- D. Lay pipe to slope gradient noted on Drawings.
- E. Install bedding of Type E material at sides and over top of pipe per standard detail.
- F. Place bedding in maximum 6 inch lifts, consolidating each lift.
- G. Refer to Section 31 23 33, "Piped Utilities - Basic Methods," for backfill and compaction requirements. Do not displace or damage pipe when compacting.
- H. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. Prior to the placing of a length of pipe, the end of the previously laid length shall be carefully and thoroughly wiped smooth and cleaned to obtain an even and close fitting joint.
- I. No length of pipe shall be laid until the preceding lengths of pipe have been thoroughly embedded in place, so as to prevent movement or disturbance of the pipe.
- J. Where existing pipe is to be extended, the same type of pipe shall be used unless otherwise specified or directed.
- K. Only full lengths of pipe are to be used in the installation, except that partial lengths of pipe may be used at the entrance to structures where necessary to obtain a proper connection to the structure.
- L. All pipe entering structures shall be cut flush with the inside face of the structure, and the cut ends of the pipe and 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.
- M. The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be done at the Contractor's risk.
- N. At all times when pipe laying is not in progress, all open ends of all pipes shall be closed by approved temporary watertight 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.

3.04 INSTALLATION - MANHOLES AND CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.05 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Division 1.

3.06 PROTECTION

- A. Protect finished installation under provisions of Division 1.
- B. Protect pipe and bedding from damage or displacement until backfilling operation in progress.

3.07 TESTING

- A. Leakage Tests. Leakage through the joints of all sanitary sewer pipe shall not exceed the following allowable limits:

100 gallons per inch of tributary pipe diameter per twenty-four (24) hours per mile of length of the computed equivalent for shorter lengths and shorter periods of time. All sanitary sewers shall be tested.

1. Infiltration Test: This test is to be conducted when the height of ground water table is 2 feet or more above the elevation of the inside crown of pipe at the upstream limit of the section being tested.

The infiltration test shall be made by installing a weir or other measuring device approved by the Engineer in the lower end of the sewer section to be tested. The quantity of ground water infiltration into the sewer shall be measured and shall not exceed the allowable leakage.

2. Exfiltration Test: This test is to be conducted when the height of the ground water table is less than 2 feet above the elevation of the inside crown of pipe at the upstream limit of the section being tested.

In general, a test section shall include the distance between two (2) successive manholes. Should the test section fail the exfiltration test, the entire system installed shall be tested, either manhole to manhole or as a whole as directed by the Engineer. The inlet end of the upstream and downstream manholes shall be closed with a watertight bulkhead and the sewer, along with the upstream manhole, shall be filled with water until the elevation of the water in the upstream manhole is 2 feet higher than the inside crown of the pipe in the section being tested, or 2 feet above the existing ground water in the trench, whichever is the higher elevation. The length of section to be tested may be filled and maintained full of water for a period of approximately twenty-four (24) hours prior to the start of the test. If the water level in the upper manhole has dropped during this twenty-four (24) hour period, the level shall be raised to the test elevation marked prior to the measurement of leakage. If the Contractor elects to test at any time during the twenty-four (24) hour period, the water shall be set at the test elevation mark and the test made.

The exfiltration will be determined by measuring the volume of water that is required to be added to return the surface of the water in the upstream manhole to the test elevation mark. The test period shall be a minimum of one (1) hour duration from the start of the test.

The Engineer, because of adjacent trench material consideration, may order that after the completion of the exfiltration test the test section of line shall be drained and the infiltration, under existing ground conditions, shall be measured within three (3) hours by means of a weir located in the downstream manhole.

The allowable leakage is based on maximum difference in elevation of 8 feet between the level of water in the upper manhole and the invert of the bulkhead pipe at the downstream manhole. If the difference in elevation exceeds 8 feet, the allowable leakage shall be increased 5% for each 1 foot in excess of eight feet.

3. Air Test: In lieu of exfiltration tests required for pipe sizes 8 inches through 24 inches and subject to approval of the Engineer, the Contractor may request an air test for checking tightness of sanitary sewer pipe construction. Air test shall conform to ASTM F-1417. Selection sections or sections of pipe between manholes shall be tested. Manholes shall be tested by plugging connecting pipe and filling with water to 2 feet from the crown of the highest entering pipe. After the filled manhole has been allowed to stand for twenty-four (24) hours, no loss of water will be permitted in a four (4) hour period.

Air testing of pipes will be accomplished only by use of equipment that has been approved by the Engineer and in accordance with the following steps:

- a. Plug all pipe outlets with suitable test plugs. Brace each plug securely.
- b. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.
- c. After an internal pressure of 4.0 psig is obtained, allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
- d. When pressure decreases to 3.5 psig, start stop-watch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding time for runs of single pipe diameter and for systems of 4 inch, 6 inch, or 8 inch laterals in combination with trunk lines shall be as published in tables by the National Clay Pipe Institute.

In the event the allowable leakage limits are not met, the Contractor shall determine the location where excess water is entering or leaving the sewer. The sewer and/or manholes shall be repaired in a manner satisfactory to the Engineer and retested until the leakage is within the allowable limit.

The Contractor shall include, in the price bid per linear foot of sewer, the cost of all bulkheads, plugs, pipe stopper, pumps, compressors, water, weirs, labor, delays, and any other items of cost necessary for the performance and completion of the required leakage test and for the cost of any repairs of adjustments which may be necessary to make the project conform to the required allowable leakage limits.

All leakage tests shall be conducted under the supervision of the Engineer or his/her representative.

4. Manholes: Manholes shall be air tested per ASTM C-1244.

- B. Deflection: Prior to final acceptance of completed thermoplastic sewer lines, the Contractor shall, at his/her expense, perform a pipe deflection test on all main line sanitary sewers.

All lines shall be measured for vertical ring deflection no sooner than thirty (30) days after completion of backfilling operations, provided in the judgment of the Engineer, sufficient settlement of the backfill has occurred. The Engineer shall be the sole judge as to when sufficient settlement has occurred.

The maximum limit of vertical deflection shall not exceed 5% of the base inside diameter of the pipe as presented in Appendix XI of ASTM D-3034.

The test shall be accomplished by manually pulling an approved "go, no-go" mandrel with nine (9) arms.

The Contractor shall be responsible to provide all equipment and labor, including mandrel, to perform and conduct the required test. The Contractor shall also be responsible to notify the Engineer at least forty-eight (48) hours in advance of the anticipated date of the testing for scheduling of personnel needed to monitor the testing operations.

In areas where deflections exceed the 5% limit, the Contractor, at no additional expense to the Owner, will correct the problem area(s) as directed by the Engineer by one of the following procedures:

1. Trench shall be re-excavated, the backfill and pipe removed and replaced in accordance with the original plans and specifications. If in the opinion of the Engineer or his/her representative the pipe has been damaged the pipe shall be replaced with new pipe and installed per the plans and specifications. The failed sections of pipe corrected by this method shall be retested in accordance with this section no sooner than thirty (30) days after the correction is made or otherwise directed by the Engineer.
2. The failed section(s) will be rerounded by means of an internal pneumatic vibratory compactor, performed by an approved company providing this service. Methods, types of equipment, and company to provide service shall be submitted in writing to the Engineer for approval at least five (5) working days in advance of performing this procedure. This method may only be used if approved by the Engineer and it is determined that the deflection has not exceeded 10% of the base inside diameter of the pipe, by pulling a nine (9) arm "go, no-go" mandrel having a diameter equal to 90% of the base inside diameter of the pipe.

After either Procedure 1 or 2 is completed, the repaired area(s) will be retested according to this section prior to final acceptance.

END OF SECTION

SECTION 33 40 00

STORM DRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Connection of building and site storm water drainage system to municipal sewers.
- C. Catch basins, curb inlets, manholes, underdrains, and headwalls.
- D. Rock channel protection.
- E. Permits, inspection fees, tap fees, etc.

1.02 RELATED SECTIONS

- A. Section 31 23 33, "Piped Utilities - Basic Methods"
- B. Section 03 30 00, "Cast-in-Place Concrete"
- C. Section 31 00 00, "Earthwork"

1.03 REFERENCES

- A. ASTM A74-87: Specification for Cast Iron Soil Pipe and Fittings.
- B. ANSI/ASTM C76-89: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- C. ASTM D1248-89: Polyethylene Plastics Molding and Extrusion Materials.
- D. ASTM D2321-89: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- E. ASTM D-3034-89: Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- F. ASTM D3212-89: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- G. ASTM F405-89: Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
- H. ASTM F794: Standard Specification for Poly(Vinyl Chloride) (PVC), Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- I. Uni-Bell, Uni-B-9: Recommended Standard Performance Specifications for Poly(Vinyl Chloride) (PVC), Large Diameter Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

- J. AASHTO M252: Standard Specification for Corrugated Polyethylene Drainage Tubing, 3 to 10 Inches Diameter.
- K. AASHTO M 294: Standard Specification for Corrugated Polyethylene Pipe, 4 to 60 Inches Diameter.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable City code for materials and installation of the Work of this Section.
- B. Contractor to obtain and pay for all required permits, tap fees, inspection fees, etc., as required by Governing Authority.

1.05 SUBMITTALS

- A. Submit shop drawings under provisions of Division 1.
- B. Submit shop drawings indicating dimensions, and invert elevations of manholes and cleanouts.
- C. Submit product data under provisions of Division 1.
- D. Submit product data for pipe, manholes, castings, and pipe accessories.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Division 1.
- B. Accurately record location of pipe runs, connections, catch basins, manholes, cleanouts, and invert elevations if different than shown on plans.
- C. Identify and describe unexpected variations to subsoil condition or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Pipe Size: 12 Inches or Larger.
 - 1. Reinforced Concrete Pipe: ANSI/ASTM C76, Class III mesh reinforcement, inside nominal diameter as shown on plans, bell and spigot end joints, tongue and groove end joints.
 - 2. Concrete Pipe Joint Device: Flexible Plastic Gaskets: AASHTO M198, Type B, Mastic joint / ANSI/ASTM C443, rubber compression gasket joint
 - 3. Smooth Interior Corrugated Polyethylene Pipe and Fittings: AASHTO M 294 Type S.
 - 4. Smooth Interior Ribbed Poly (Vinyl Chloride) (PVC) Gravity Sewer Pipe & Fittings: ASTM F794, Uni-Bell, Uni-B-9.

- B. Pipe Size: Less than 12 inches.
 - 1. Service weight cast iron soil pipe and fittings for sizes through 15 inches: Bell and spigot type conforming to ASTM A74.
 - 2. Type PSM Poly (Vinyl Chloride) (PVC) sewer pipe and fittings ASTM D-3034, joints per ASTM D-3212.
 - 3. Smooth Interior Corrugated Polyethylene Pipe and Fittings: AASHTO M 252 Type S.
 - 4. Smooth Interior Ribbed Poly (Vinyl Chloride) (PVC) Gravity Sewer Pipe & Fittings: ASTM F794, Uni-Bell, Uni-B-9.

2.02 CATCH BASINS, CURB INLETS

- A. Basin Lid and Frame: Cast iron construction, nominal lid and frame size as shown on plans manufactured by Neenah Foundry Co. or equal.
- B. Shaft and Top Section: Reinforced precast concrete, lipped male/female joints; nominal dimensions as shown on plans. Cast-in-place, brick or block side walls may be used in place of precast construction. Brick or concrete block side walls shall be 8 inches nominal thickness. When brick or concrete block are used, the outside walls of the manhole shall be plastered with a 1/2 inch coat of lime cement mortar.
- C. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, "Cast-in-Place Concrete"; leveled top surface to receive concrete shaft sections, sleeved to receive storm sewer pipe sections. Precast base sections may be used in lieu of cast-in-place base.

2.03 MANHOLES

- A. Lid and Frame: Cast iron construction, removable lid, open checkerboard grill 22 1/4 inches.
- B. Shaft Construction and Eccentric Cone Top Section: Reinforced precast concrete pipe sections, lipped male/female joints; cast steel ladder rungs into shaft sections at 16 inches; nominal shaft diameter of 48 inches. Cast-in-place, brick or block side walls may be used in place of precast construction. Brick or concrete block side walls shall be 8 inches nominal thickness. When brick or concrete block are used, the outside walls of the manhole shall be plastered with a 1/2 inch coat of lime cement mortar.
- C. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, "Cast-in-Place Concrete"; leveled top surface to receive concrete shaft sections, sleeved to receive sewer pipe sections. Precast base sections may be used in lieu of cast-in-place base.

2.04 HEAD WALLS

- A. Size and type as shown on plans.

2.05 UNDER DRAINS

- A. Filter Fabric: Mirafi Geotextile, 160N or equal.
- B. Filter Aggregate: ODOT #8/Type H.
- C. Tubing: Polyethylene tubing, ASTM F-405 / AASHTO M 252.

2.06 CLEANOUTS

- A. Cleanouts shall be adjustable, vandal-proof with heavy duty cast iron top for exterior use.
 - 1. Zurn Z-1400-VP, as manufactured by Zurn Industries, Inc.
 - 2. Jay R. Smith 4220-U, as manufactured by Jay R. Smith Manufacturing Co.

2.07 ROCK CHANNEL PROTECTION

The material shall consist of sound durable rock broken concrete or stone. Reinforcing steel in broken concrete shall not protrude beyond the surface of the concrete. A filter shall be placed consisting of filter fabric or a 6 inches bed of No. 3 or 4 crushed gravel stone or slag. Filter fabric shall be placed with long dimension parallel to the flow and shall be laid loosely but without wrinkles.

This material shall be one (1) of four (4) types defined below:

Type A shall consist of sizes such that at least 85% of the total material by weight shall be larger than an 18 inch but less than a 30 inch square opening. At least 50% of material by weight shall be larger than a 24 inch square opening. The material smaller than an 18 inch square opening shall consist predominantly of rock spalls and rock fines and shall be free of soil.

Type B shall consist of sizes such that at least 85% of the total material by weight shall be larger than a 12 inch but less than a 24 inch square opening. At least 50% of the total material by weight shall be larger than an 18 inch square opening. The material smaller than a 12 inch square opening shall consist predominantly of rock spalls and rock fines and shall be free of soil.

Type C shall consist of sizes such that at least 85% of the total material by weight shall be larger than a 6 inch but less than an 18 inch square opening. At least 50% of the total material by weight shall be larger than a 12 inch square opening. The material smaller than a 6 inch square opening shall consist predominantly of rock spalls and rock fines and shall be free of soil.

Type D shall consist of sizes such that at least 85% of the total material by weight shall be larger than a 3 inch but less than a 12 inch square opening. At least 50% of the total material by weight shall be larger than a 6 inch square opening. The material smaller than a 3 inch square opening shall consist predominantly of rock spalls and rock fines and shall be free of soil.

2.08 TRENCH DRAINS

- A. Lid and Frame: Cast iron construction nominal lid and frame size as shown on plans. Model No. Neenah R-4999-BX with Type "C" grate or East Jordan Iron Works V-7362.

2.09 AREA DRAINS

- A. 12 inch square top drain, Dura-Coated cast iron body with bottom outlet, seepage pan and combination membrane flashing clamp and frame for heavy duty cast iron loose slotted grate with suspended sediment bucket.
 - 1. ZURN Z-610, as manufactured by Zurn Industries, Inc.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut is ready to receive work, and excavations, dimensions, and elevations are as indicated on Plans.
- B. Beginning of installation means acceptance of existing conditions.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with Type A or Type D fill material.
- B. Remove large stones or other hard matter which could damage storm sewer or impede consistent backfilling or compaction.

3.03 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories, in accordance with ANSI/ASTM C76, ASTM D2321, and manufacturer's instructions.
- B. Bed sewer with Type E fill material per standard drawing provided on plans.
- C. Lay pipe to slope gradients noted on Drawings.
- D. Place bedding material in maximum 6 inch lifts, consolidating each lift.
- E. Backfill and compact per the requirements of Section 31 23 33, "Piped Utilities - Basic Methods." Do not displace or damage pipe when compacting.

3.04 INSTALLATION - CATCH BASINS, MANHOLES, AND CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation, provide 6 inches of Type E fill material under base.
- B. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
- E. Form invert channel in manhole to spring line of sewer.

3.05 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Division 1.

3.06 PROTECTION

- A. Protect finished installation under provisions of Division 1.

END OF SECTION