# UPPER POTTSGROVE TOWNSHIP
# NEW MUNICIPAL COMPLEX

UPPER POTTSGROVE TOWNSHIP

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VOLUME 2 OF 2

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With[polished, chrome-plated finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   2. Escutcheons for Existing Piping:
      a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
      f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   New Piping: One-piece, floor-plate type.
   1. Existing Piping: Split-casting, floor-plate type.

## 3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

# SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.

B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

### 1.3 SUBMITTALS

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

### 1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

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

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
   4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Solder Joint: With sockets according to ASME B16.18.
   2. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. Conbraco Industries, Inc.; Apollo Valves.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Hammond Valve.
      e. Lance Valves; a division of Advanced Thermal Systems, Inc.
      f. Legend Valve.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Red-White Valve Corporation.
      j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

B. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. DynaQuip Controls.
      c. Hammond Valve.

d. Milwaukee Valve Company.
e. NIBCO INC.
f. Red-White Valve Corporation.

2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig (1035 kPa).
   c. CWP Rating: 600 psig (4140 kPa).
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.
   k. NIBCO INC.
   l. Red-White Valve Corporation.
   m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
3. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

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

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

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

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

### 3.2 VALVE INSTALLATION

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

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

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

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

## 3.3 ADJUSTING

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

## 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, gate, or plug valves.
   2. Throttling Service: Globe, ball, or butterfly valves.

B. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

## 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze Angle Valves: Class 125, nonmetallic disc.
   3. Ball Valves: Two piece, full port, bronze with bronze trim.

END OF SECTION 220523

# SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers

B. Related Sections:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 21 fire-suppression piping Sections for pipe hangers for fire-suppression piping.
   3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

### 1.3 DEFINITIONS

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

### 1.4 PERFORMANCE REQUIREMENTS

A. 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 and obtain approval from authorities having jurisdiction.

### 1.5 SUBMITTALS

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

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.

1.6 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.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

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

2.2 TRAPEZE PIPE HANGERS

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

B. 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.

C. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [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.

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

C. 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.

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

E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

G. 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.

H. 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 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields 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 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 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 (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.3 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 and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
   17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

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

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
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 (32 mm).
    3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
    4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
    5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
    6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
    7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
    8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
        a. Horizontal (MSS Type 54): Mounted horizontally.
        b. Vertical (MSS Type 55): Mounted vertically.
        c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-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 powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

END OF SECTION 220529

# SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.

### 1.3 SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

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

### 1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 PIPE LABELS

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

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

C. 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, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

## 2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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 surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 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.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

# SECTION 220700 - PLUMBING INSULATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Tapes.

B. Related Sections include the following:
   1. Division 23 Section "HVAC Insulation."

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Field quality-control reports.

### 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

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

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

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

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

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.

## 2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dow Chemical Company (The); 739, Dow Silicone.
      b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. P.I.C. Plastics, Inc.; Welding Adhesive.
      d. Speedline Corporation; Speedline Vinyl Adhesive.

## 2.3 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

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

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

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) 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 (50 mm) below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

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

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
   4. Seal jacket to wall flashing with flashing sealant.

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against

adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. 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, vessels, and equipment. 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.

## 3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are 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 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

## 3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the

"Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

## 3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
1. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1/2 inch (13 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:
1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

END OF SECTION 220700

# SECTION 221116 - DOMESTIC WATER PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Specialty valves.

B. Related Section:
   1. Division 22 Section "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

### 1.3 SUBMITTALS

A. Product Data: For the following products:
   1. Specialty valves.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Flexible connectors.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Fire-suppression-water piping.
   2. Domestic water piping.
   3. Compressed air piping.
   4. HVAC hydronic piping.

D. 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 61 for potable domestic water piping and components.

1.5 PROJECT CONDITIONS

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

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 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   4. Copper Pressure-Seal-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         1) Elkhart Products Corporation; Industrial Division.
         2) NIBCO INC.
         3) Viega; Plumbing and Heating Systems.
      b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   5. Copper Push-on-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         1) NVent LLC.
      b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
   6. Copper-Tube Extruded-Tee Connections:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) T-DRILL Industries Inc.
      b. Description: Tee formed in copper tube according to ASTM F 2014.
   7. Grooved-Joint Copper-Tube Appurtenances:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1) Anvil International.
   2) Shurjoint Piping Products.
   3) Victaulic Company.
b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

## 2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; 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. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 2.4 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

## 2.5 TRANSITION FITTINGS

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

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

C. Plastic-to-Metal Transition 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. Charlotte Pipe and Foundry Company.

b. Harvel Plastics, Inc.
c. Spears Manufacturing Company.

## 2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

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.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.
2. Description:

a. Pressure Rating: 150 psig (1035 kPa) at 180 deg F (82 deg C).
b. 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.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig (1035 kPa).
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric 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. Calpico, Inc.
b. Lochinvar Corporation.
2. Description:
a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

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. Perfection Corporation; a subsidiary of American Meter Company.
      b. Precision Plumbing Products, Inc.
      c. Victaulic Company.
   2. Description:
      a. Electroplated steel nipple complying with ASTM F 1545.
      b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      c. End Connections: Male threaded or grooved.
      d. Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 PIPING INSTALLATION

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

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. 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 in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

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

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

I. 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.

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

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than 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 from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

S. Install thermometers on inlet and outlet piping from each water heater. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

## 3.2 JOINT CONSTRUCTION

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

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

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: 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: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

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

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

J. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.

K. PEX Piping Joints: Join according to ASTM F 1807.

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

## 3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves.

## 3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
   2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

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

## 3.5 DIELECTRIC FITTING INSTALLATION

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

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

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

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

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

G. Install supports for vertical steel piping every 15 feet (4.5 m).

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

B. Install piping adjacent to equipment and machines to allow 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
   4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. 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:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2. 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.
3. 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.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
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 for corrective action required.

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

E. Prepare test and inspection reports.

## 3.10 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 flow of hot water 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.

## 3.11 CLEANING

A. Clean and disinfect potable[ and 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 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 (50 mg/L) 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 (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

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

## 3.12 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. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint copper-tube appurtenances; and grooved joints.

## 3.13 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 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: [Calibrated] [Memory-stop] balancing valves.
4. Drain Duty: Hose-end drain valves.

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

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

# SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Water hammer arresters.

### 1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

### 1.4 SUBMITTALS

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

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

## PART 2 - PRODUCTS

### 2.1 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
   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. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      d. PPP 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 Inc.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

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

### 3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
1. Test each device according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 221119

# SECTION 221316 - SANITARY WASTE AND VENT PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

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

B. Related Sections:
   1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

### 1.3 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.

### 1.5 PROJECT CONDITIONS

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

## 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, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ANACO-Husky.
   b. Dallas Specialty & Mfg. Co.
   c. Fernco Inc.
   d. Matco-Norca, Inc.
   e. MIFAB, Inc.
   f. Mission Rubber Company; a division of MCP Industries, Inc.
   g. Stant.
   h. Tyler Pipe.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, 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. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. 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 (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International; a subsidiary of Mueller Water Products, Inc.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products.
d. Victaulic Company.
2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

## 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. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

# PART 3 - EXECUTION

## 3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "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. 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.

K. 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.

L. Install soil and waste drainage and vent piping at the minimum slopes indicated on the plans.

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 aboveground PVC piping according to ASTM D 2665.

O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

Q. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

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

## 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. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

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

F. 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. 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 Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal or vertical piping in noncorrosive environments.
   2. Install stainless-steel pipe hangers for horizontal or vertical piping in corrosive environments.
   3. Vertical Piping: MSS Type 8 or Type 42, clamps.
   4. Install individual, straight, horizontal piping runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
   5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 (300 mm) of each fitting, valve, and coupling.

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

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) 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 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
   4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
   5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
   6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
   5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

J. Install supports for vertical PVC piping every 48 inches (1200 mm).

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 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.

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 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

## 3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "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 (30 kPa). 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 (250 Pa). 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.

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 (345 kPa) 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 AND PROTECTION

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

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

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

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

B. Aboveground, soil, waste and vent piping NPS 1-¼ (DN 100) and larger shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings[ and sovent stack fittings]; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.
   3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground, soil, waste, and vent piping NPS 2 and larger shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
   3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Sanitary-sewage force mains NPS 1-1/2 and larger shall be any of the following:
   1. Solid-wall PVC pressure pipe, PVC socket fittings, and solvent-cemented joints.

E. END OF SECTION 221316

# SECTION 224000 - PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets for lavatories, showers, and sinks.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Shower receptors.
   7. Water closets.
   8. Urinals.
   9. Lavatories.
   10. Sinks.
   11. Service basins.

B. Related Sections include the following:
   1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
   2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
   3. Division 22 Section "Domestic Water Filtration Equipment" for water filters.
   4. Division 22 Section "Drinking Fountains and Water Coolers."
   5. Division 31 Section "Facility Water Distribution Piping" for exterior plumbing fixtures and hydrants.

### 1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub

spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

## 1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. LEED Submittal:
   1. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

## 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Plastic Bathtubs: ANSI Z124.1.
3. Plastic Lavatories: ANSI Z124.3.
4. Plastic Laundry Trays: ANSI Z124.6.
5. Plastic Mop-Service Basins: ANSI Z124.6.
6. Plastic Shower Enclosures: ANSI Z124.2.
7. Plastic Sinks: ANSI Z124.6.
8. Plastic Urinal Fixtures: ANSI Z124.9.
9. Plastic Whirlpool Bathtubs: ANSI Z124.1 and ASME A112.19.7M.
10. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
11. Slip-Resistant Bathing Surfaces: ASTM F 462.
12. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
13. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
14. Stainless-Steel Residential Sinks: ASME A112.19.3.
15. Vitreous-China Fixtures: ASME A112.19.2M.
16. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
17. Water-Closet, Flushometer Tank Trim: ASSE 1037.
18. Whirlpool Bathtub Fittings: ASME A112.19.8M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for shower faucets:
1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.
7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Hot-Water Dispensers: ASSE 1023 and UL 499.
8. Off-Floor Fixture Supports: ASME A112.6.1M.
9. Pipe Threads: ASME B1.20.1.
10. Plastic Shower Receptors: ANSI Z124.2.
11. Plastic Toilet Seats: ANSI Z124.5.
12. Supply and Drain Protective Shielding Guards: ICC A117.1.
13. Whirlpool Bathtub Equipment: UL 1795.

## 1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures of unit shell.
   b. Faulty operation of controls, blowers, pumps, heaters, and timers.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Commercial Applications: One year from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan
   b. American Standard Companies, Inc.
   c. Bradley Corporation.
   d. Chicago Faucets.
   e. Delta Faucet Company.
   f. Eljer.
   g. Elkay Manufacturing Co.
   h. Fisher Manufacturing Co.
   i. Grohe America, Inc.
   j. Just Manufacturing Company.
   k. Kohler Co.
   l. Moen, Inc.
   m. Royal Brass Mfg. Co.
   n. Sayco; a Briggs Plumbing Products, Inc. Company.
   o. Speakman Company.
   p. T & S Brass and Bronze Works, Inc.
   q. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: Hand Washing Faucet for hot/cold water operation.. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Maximum Flow Rate: 0.5 gpm (1.5 L/min).
   b. Centers: 4 inches (102 mm).
   c. Mounting: Deck, exposed.
   d. Inlet(s): NPS 3/8 (DN 10) tubing, plain end.
   e. Spout: Rigid type.
   f. Spout Outlet: Aerator.
   g. Drain: Grid.

## 2.2 SHOWER FAUCETS

A. Shower Faucets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Brasstech Inc.; Newport Brass Div.
      c. Broadway Collection.
      d. Central Brass Manufacturing Company.
      e. Chicago Faucets.
      f. Delta Faucet Company.
      g. Eljer.
      h. Gerber Plumbing Fixtures LLC.
      i. Hansgrohe Inc.
      j. Kohler Co.
      k. Leonard Valve Company.
      l. Moen, Inc.
      m. Paul Decorative Products.
      n. Pegler, Ltd.
      o. Powers; a Watts Industries Co.

p. Price Pfister, Inc.
q. Rohl LLC.
r. Royal Brass Mfg. Co.
s. Sayco; a Briggs Plumbing Products, Inc. Company.
t. Speakman Company.
u. Sterling Plumbing Group, Inc.
v. St. Thomas Creations.
w. Symmons Industries, Inc.
x. T & S Brass and Bronze Works, Inc.
y. Wolverine Brass, Inc.
z. Zurn Plumbing Products Group; AquaSpec Commercial Faucet Operation.

2. Description: Single-handle pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
   a. Body Material: Solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   d. Mounting: Exposed.
   e. Backflow Protection Device for Hand-Held Shower: Required.
   f. Operation: Compression, manual.
   g. Antiscald Device: Integral with mixing valve.
   h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
   i. Supply Connections: NPS 1/2 (DN 15).
   j. Shower Head Type: Hand held, slide-bar mounted.
   k. Spray Pattern: Adjustable.
   l. Integral Volume Control: Not required.

## 2.3 SINK FAUCETS

A. Sink Faucets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Bradley Corporation.
      c. Broadway Collection.
      d. Chicago Faucets.
      e. Delta Faucet Company.
      f. Dormont Manufacturing Company.
      g. Eljer.
      h. Elkay Manufacturing Co.
      i. Fisher Manufacturing Co.
      j. Grohe America, Inc.
      k. Just Manufacturing Company.
      l. Kohler Co.
      m. Moen, Inc.
      n. Royal Brass Mfg. Co.
      o. Sayco; a Briggs Plumbing Products, Inc. Company.
      p. Speakman Company.

q. T & S Brass and Bronze Works, Inc.
r. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Kitchen faucet with spray, three-hole or four-hole fixture. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Body Material: Commercial, solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   d. Mixing Valve: Single control.
   e. Backflow Protection Device for Hose Outlet: Required.
   f. Backflow Protection Device for Side Spray: Required.
   g. Centers: Single hole.
   h. Mounting: Deck, exposed.
   i. Handle(s): Lever.
   j. Inlet(s): NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter.
   k. Spout Type: Swing, shaped tube.
   l. Spout Outlet: Aerator.
   m. Vacuum Breaker: Required.
   n. Operation: Compression, manual.
   o. Drain: Not required.

## 2.4 FLUSHOMETERS

A. Flushometers, Water Closets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hydrotek International, Inc.
      b. Sloan Valve Company.
      c. TOTO USA, Inc.
   2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: piston operation.
      b. Style: Exposed.
      c. Inlet Size: )NPS 1 (DN 25).
      d. Trip Mechanism: Battery-operated sensor actuator , with mechanical override.
      e. Consumption: 1.6 gal./flush (6.0 L/flush).
      f. Tailpiece Size: NPS 1-1/2 (DN 40) and standard length to top of bowl.

B. Flushometers, Urinals :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hydrotek International, Inc.
      b. Sloan Valve Company.
      c. TOTO USA, Inc.
   2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components,[ non-hold-open feature,] control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: piston operation.
      b. Style: Exposed.

c. Inlet Size: NPS 3/4 (DN 20).
d. Trip Mechanism: Battery-operated sensor actuator , with mechanical override.
e. Consumption: 1.0 gal./flush (3.8 L/flush).
f. Tailpiece Size: NPS 3/4 (DN 20) and standard length to top of bowl.
g.

## 2.5 TOILET SEATS

A. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.
b. Bemis Manufacturing Company.
c. Centoco Manufacturing Corp.
d. Church Seats.
e. Eljer.
f. Kohler Co.
g. Olsonite Corp.
h. Sanderson Plumbing Products, Inc.; Beneke Div.
i. Sperzel.
2. Description: Toilet seat for water-closet-type fixture.
a. Material: Molded, solid plastic with antimicrobial agent.
b. Configuration: Open front without cover.
c. Size: Elongated.
d. Hinge Type: CK, check.
e. Class: Standard commercial.
f. Color: White.

## 2.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Engineered Brass Co.
b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
c. McGuire Manufacturing Co., Inc.
d. Plumberex Specialty Products Inc.
e. TCI Products.
f. TRUEBRO, Inc.
g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
h. <Insert manufacturer's name.>
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
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. TRUEBRO, Inc.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

## 2.7 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Urinal Supports:
1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

C. Lavatory Supports,
1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

## 2.8 SHOWER RECEPTORS

A. Shower Receptors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Aker Plastics Co., Inc.
b. Crane Plumbing, L.L.C./Fiat Products.
c. Florestone Products Co., Inc.
d. LASCO Bathware.
e. Mustee, E. L. & Sons, Inc.
f. Sterling Plumbing Group, Inc.
g. Swan Corporation (The).
2. Description: FRP base for built-up-type shower fixture.
a. Type: Handicapped/wheelchair.
b. Size: 36 by 36 inches (914 by 914 mm).
c. Color: White.
d. Outlet: Drain with NPS 3 (DN 80) outlet.

## 2.9 WATER CLOSETS

A. Water Closets, WC-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Gerber Plumbing Fixtures LLC.
   c. Kohler Co.
   d. Mansfield Plumbing Products, Inc.
   e. St. Thomas Creations.
2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture.
   a. Style: Tank type.
      1) Bowl Type: Elongated with siphon-jet design.
      2) Height: Accessible.
      3) Design Consumption: 1.6 gal./flush (6 L/flush).
      4) Color: White.

## 2.10 URINALS

A. Urinals, UR-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Briggs Plumbing Products, Inc.
      c. Capizzi.
      d. Crane Plumbing, L.L.C./Fiat Products.
      e. Duravit USA, Inc.
      f. Eljer.
      g. Kohler Co.
      h. Mansfield Plumbing Products, Inc.
      i. Peerless Pottery, Inc.
      j. Sanitarios Azteca, S.A. de C.V.
      k. St. Thomas Creations.
      l. TOTO USA, Inc.
   2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Type: Siphon jet.
      b. Strainer or Trapway: Integral cast strainer with integral trap.
      c. Design Consumption: 1 gal./flush (3.8 L/flush).
      d. Color: White.
      e. Supply Spud Size: NPS 3/4 (DN 20).
      f. Outlet Size: NPS 2 (DN 50).

## 2.11 LAVATORIES

A. Lavatories, L-1; L-2:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Barclay Products, Ltd.
      c. Briggs Plumbing Products, Inc.

d. Crane Plumbing, L.L.C./Fiat Products.
e. Eljer.
f. Gerber Plumbing Fixtures LLC.
g. Kohler Co.
h. Mansfield Plumbing Products, Inc.
i. Peerless Pottery, Inc.
j. Sterling Plumbing Group, Inc.
k. St. Thomas Creations.
l. TOTO USA, Inc.

2. Description: Accessible, wall-mounting, vitreous-china fixture designed for people in wheelchairs.
   a. Type: With back.
   b. Size: 20 by 18 inches (508 by 457 mm) rectangular.
   c. Faucet Hole Punching: Three holes, 2-inch (51-mm) centers.
   d. Faucet Hole Location: Top.
   e. Pedestal: Not required.
   f. Color: White.
   g. Faucet: Lavatory for separate drain.
   h. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
   i. Drain: Grid.
      1) Location: Near back of bowl.
   j. Drain Piping: Schedule 40 ABS or PVC, NPS 1-1/4 (DN 32) trap; NPS 1-1/4 (DN 32), tubular waste to wall; and wall escutcheon.
   k. Hair Interceptor: Not required.
   l. Fixture Support: Lavatory.

## 2.12 SINKS

A. Kitchen Sinks, S-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dayton Products, Inc.
      b. Elkay Manufacturing Co.
      c. Kohler Co.
      d. Moen, Inc.
   2. Description: Two-bowl, counter-mounting, stainless-steel kitchen sink.
      a. Overall Dimensions: 33x22x7.5.
      b. Metal Thickness: #20 gauge .
      c. Bowl:
         1) Drain: 3-1/2-inch (89-mm) crumb cup.
      d. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
      e. Drain Piping: Schedule 40 ABS or PVC, NPS 1-1/2 (DN 40) P-trap; tubular waste to wall;and wall escutcheon(s).
      f. Disposer: Not required
      g. Dishwasher Air-Gap Fitting: Not required.
      h. Hot-Water Dispenser: Not required.

## 2.13 SERVICE BASINS

A. Service Basins MSB:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Plumbing, L.L.C./Fiat Products.
      b. Florestone Products Co., Inc.
      c. Mustee, E. L. & Sons, Inc.
      d. Swan Corporation (The).
      e. Zurn Plumbing Products Group; Light Commercial Operation.
   2. Description: Flush-to-wall, floor-mounting, cast-polymer fixture with rim guard.
      a. Shape: Square.
      b. Size: 24 by 24 inches (610 by 610 mm).
      c. Height: 10 inches (255 mm).
      d. Rim Guard: On all top surfaces.
      e. Color: Not applicable .
      f. Faucet: Chrome plated with vacuum breaker, integral stops, adjustable wall brace, pail hook and3⁄4” hose thread on spout..
      g. Drain: Grid with NPS 3 (DN 80) outlet.

## 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 plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

### 3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."

R. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

## 3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

## 3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

## 3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

# SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

## 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. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

### 1.3 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

### 1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

## 1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filter Cartridges: no fewer than 2 of each.

# PART 2 - PRODUCTS

## 2.1 PRESSURE WATER COOLERS (EWC)

A. Water Coolers, bi-level:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co.
      b. Halsey Taylor.
      c. Haws Corporation.
      d. Larco, Inc.
      e. Oasis Corporation.
      f. Sunroc Corp.
   2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for child-mounting height.
      a. Cabinet: Bilevel with two attached cabinets, vinyl-covered steel with stainless-steel top.
      b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
      c. Control: Push bar.
      d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
      e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
      f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.
      g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
2) Electrical Characteristics: ¼ hp; 120-V ac; single phase; 60 Hz.

h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

## 2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

## 3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

## 3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to 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 Division 22 Section "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

## 3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
   1. Remove and replace malfunctioning units and retest as specified above.
   2. Report test results in writing.

## 3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

## 3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

# SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Pipe stands.
   6. Equipment supports.

B. Related Sections include the following:
   1. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
   2. Division 23 Section " Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.

### 1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

### 1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.

## PART 2 - PRODUCTS

### 2.1 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. Bergen-Power Pipe Supports.
   2. B-Line Systems, Inc.; a division of Cooper Industries.
   3. Grinnell Corp.
   4. National Pipe Hanger Corporation.
   5. PHS Industries, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.2 TRAPEZE PIPE HANGERS

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

## 2.3 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

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

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

G. Insert Length: Extend 2 inches (50 mm) 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.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

## 2.5 PIPE STAND FABRICATION

A. Pipe Stands, General: 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.
   1. Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.

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

D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## 2.6 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

# PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified 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 padded hangers for piping that is subject to scratching.

F. 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 (DN 15 to DN 750).
   2. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
   3. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
   4. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   5. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
   6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
   7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.

G. 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 20 (DN 20 to DN 500).

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weld-less Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. C-Clamps (MSS Type 23): For structural shapes.

J. 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.

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

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

## 3.2 HANGER AND SUPPORT INSTALLATION

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

B. 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. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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 (100 mm) 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. Install hangers and supports complete with necessary 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 lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

K. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. 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 according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields 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 (DN 100) and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   5. Insert Material: Length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.3 EQUIPMENT SUPPORTS

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

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

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

## 3.4 METAL FABRICATIONS

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

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

## 3.5 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

## 3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

# SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Valve tags.

### 1.2 SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

### 1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) 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 (64 by 19 mm).
   3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   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.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   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.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify equipment. 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. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid 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, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

## 2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Brass, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:
   1. Chilled-Water Piping:
      a. Background Color: Blue.
      b. Letter Color: Black.
   2. Condenser-Water Piping:
      a. Background Color: Blue.
      b. Letter Color: Black.
   3. Heating Water Piping:
      a. Background Color: Red.
      b. Letter Color: Black.
   4. Refrigerant Piping:
      a. Background Color: Green.
      b. Letter Color: Black.
   5. Low-Pressure Steam Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   6. High-Pressure Steam Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   7. Steam Condensate Piping:

a. Background Color: Yellow.
b. Letter Color: Black.

## 3.4 VALVE-TAG INSTALLATION

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

END OF SECTION 230553

# SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.

### 1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

### 1.3 SUBMITTALS

A. Qualification Data: Submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB reports.

### 1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage an independent TAB entity certified by AABC, NEBB, or TABB.

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.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

### 1.5 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

A. Notice: Provide seven days' advance notice for 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.

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 locations of 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 system and equipment controls.

E. Examine equipment performance data including fan and pump curves.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on HVAC equipment.

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 strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
   1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.4 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. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections and functioning.

I. Check for proper sealing of air-handling-unit components.

J. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

## 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
      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 flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Report the cleanliness status of filters and the time static pressures are measured.
   4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
   5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   6. 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 main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of 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.

## 3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

## 3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

## 3.8 TOLERANCES

A. Set HVAC system's air flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

## 3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Face and bypass damper settings at coils.
      e. Fan drive settings including settings and percentage of maximum pitch diameter.
      f. Inlet vane settings for variable-air-volume systems.
      g. Settings for supply-air, static-pressure controller.
      h. Other system operating conditions that affect performance.

D. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.

h. Sheave make, size in inches (mm), and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Filter static-pressure differential in inches wg (Pa).
   f. Preheat-coil static-pressure differential in inches wg (Pa).
   g. Cooling-coil static-pressure differential in inches wg (Pa).
   h. Heating-coil static-pressure differential in inches wg (Pa).
   i. Outdoor airflow in cfm (L/s).
   j. Return airflow in cfm (L/s).
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

E. Apparatus-Coil Test Reports:
1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch (mm) o.c.
   f. Make and model number.
   g. Face area in sq. ft. (sq. m).
   h. Tube size in NPS (DN).
   i. Tube and fin materials.
   j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm (L/s).
   b. Average face velocity in fpm (m/s).
   c. Air pressure drop in inches wg (Pa).
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
   e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
   f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
   g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
   h. Water flow rate in gpm (L/s).
   i. Water pressure differential in feet of head or psig (kPa).
   j. Entering-water temperature in deg F (deg C).
   k. Leaving-water temperature in deg F (deg C).
   l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

H. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.

f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm (L/s).
   b. Air velocity in fpm (m/s).
   c. Preliminary air flow rate as needed in cfm (L/s).
   d. Preliminary velocity as needed in fpm (m/s).
   e. Final air flow rate in cfm (L/s).
   f. Final velocity in fpm (m/s).
   g. Space temperature in deg F (deg C).

I. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

## 3.10 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 5 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

C. Prepare test and inspection reports.

END OF SECTION 230593

# SECTION 230700 - HVAC INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Calcium silicate.
      b. Flexible elastomeric.
      c. Mineral fiber.
   2. Fire-rated insulation systems.
   3. Sealants.
   4. Factory-applied jackets.
   5. Field-applied jackets.

B. Related Sections:
   1. Division 21 Section "Fire-Suppression Systems Insulation."
   2. Division 22 Section "Plumbing Insulation."
   3. Division 23 Section "Metal Ducts" for duct liners.

### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
   1. Pipe insulating materials.
   2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   3. Detail application of field-applied jackets.

### 1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   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.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 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. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

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

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

D. Cellular-Glass Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.
   1. Preformed Pipe Insulation, without Jacket: Comply with ASTM C 552, Type II, Class 1.
   2. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSP jacket]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket.
   1. Products: Subject to compliance with requirements, provide the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Johns Manville; 800 Series Spin-Glas.
      c. Knauf Insulation; Insulation Board.
      d. Manson Insulation Inc.; AK Board.
      e. Owens Corning; Fiberglas 700 Series.

H. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000 Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   3. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ.

I. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Apache Products Company; ISO-25.
      b. Dow Chemical Company (The); Trymer.
      c. Duna USA Inc.; Corafoam.
      d. Elliott Company; Elfoam.
   2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
   3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
   4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
   5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
      a. Pipe Applications: ASJ.
      b. Equipment Applications: ASJ.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; FlameChek.
      b. Johns Manville; Firetemp Wrap.
      c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
      d. Thermal Ceramics; FireMaster Duct Wrap.
      e. 3M; Fire Barrier Wrap Products.

2.3 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
   4. Color: White or gray.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

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

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

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. 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 (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

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

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

## 3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. 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.

## 3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

F. 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 entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

## 3.8 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 (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

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-presized 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 (50 mm) 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 in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
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 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

## 3.10 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material:

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.

## 3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of

inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 3.12 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

## 3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round and flat-oval, supply-air duct insulation, conditioned space shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

B. Concealed, rectangular, round and flat-oval, supply-air duct insulation, unconditioned space shall be the following:

1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.

C. Concealed, rectangular, round and flat-oval, return-air duct insulation, conditioned space shall be the following:
   1. Mineral-Fiber Blanket: 1 inch thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

D. Concealed, rectangular, round and flat-oval, return-air duct insulation, unconditioned space shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

E. Concealed, rectangular, round and flat-oval, outdoor-air duct insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density.
   2. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

F. Concealed, rectangular, round and flat-oval, exhaust-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch (25 mm) thick.
   2. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.

G. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

H. Exposed, round and flat-oval, supply-air, return air duct insulation shall be the following:
   1. Provide 1" duct liner as specified in Section 233113 "Metal Ducts".

I. Exposed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
   1. Provide 1" duct liner as specified in Section 233113 "Metal Ducts".

J. Exposed, rectangular, supply-air, return air duct insulation shall be one of the following:
   1. Provide 1" duct liner as specified in Section 233113 "Metal Ducts".
   2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

K. Exposed, rectangular, outdoor-air duct insulation shall be one of the following:
   1. Provide 1 ½" duct liner as specified in Section 233113 "Metal Ducts".
   2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

L. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated board; thickness as required to achieve 2-hour fire rating.

## 3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

## 3.15 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch (19 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and below:
   1. NPS 12 (DN 300) and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches (50 mm) thick.

C. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch (25 mm) thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch (25 mm) thick.

END OF SECTION 230700

0SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:
   1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
   2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
   e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
   f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
   g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
   h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide: Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.

## 1.5 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including flow characteristics.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 THERMOSTATS

A. Available Manufacturers:
1. LG.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
   a. Time of day.
   b. Actual room temperature.
   c. Programmed temperature.
   d. Programmed time.
   e. Duration of timed override.

f. Day of week.
g. System mode indications include "heating," "off," "fan auto," and "fan on."

## 2.3 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Available Manufacturers:
a. Belimo Aircontrols (USA), Inc.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:
a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 120-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
12. Run Time: 12 seconds open, 5 seconds closed.

## 2.4 DAMPERS

A. Available Manufacturers:
1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

## 2.5 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

## 3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install guards on thermostats in the following locations:
   1. Entrances.
   2. Public areas.
   3. Where indicated.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

## 3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

## 3.5 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

# SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

### 1.3 CONTROL SEQUENCES

A. Air handling unit with Heat pump unit:
   1. Occupied cycle (based on TSTAT Program): Open the outside air damper for occupied minimum airflow and operate the supply fan continuously. On a rise in space temperature above the cooling set point (75degF), energize the compressor(s) in cooling mode to satisfy the thermostat. On a fall in space temperature below the heating set point (70degF), energize the compressor(s) in heating mode to satisfy the thermostat.
   2. Unoccupied Cycle (Based on TSTAT Program): Close the outside air damper. On a rise in space temperature above the cooling set point (80degF), energize the compressor(s) in cooling mode to satisfy the thermostat. On a fall in space temperature below the heating set point (65degF), energize the compressor(s) in heating mode to satisfy the thermostat.

B. Toilet Inline Exhaust Fans:
   1. Toilet Inline Exhaust Fans: Interlock with programmable thermostat auxiliary contacts to operate continuously during the occupied cycle.

C. Toilet Cabinet Exhaust Fans: Interlock fan with light switch, wiring by EC.

D. Fresh Air supply Fan
   1. Interlock with programmable thermostat auxiliary contacts to operate continuously during the occupied cycle.

### 1.4 BALANCING AND COMMISSIONING:

A. Verify proper installation of mechanical equipment prior to balancing and report any deficiencies.

B. Verify all necessary components are installed such as balancing valves and dampers.

C. Verify operation of systems and equipment complies with the specified sequence of operation in all modes.

D. Balance air systems to within 0 to + 10% of indicated values.

E. Submit reports specified under submittals.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install control wiring concealed, except in mechanical rooms, and according to requirements specified in Division 16 Sections.

END OF SECTION 230993

# SECTION 232300 - REFRIGERANT PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

### 1.3 SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

### 1.4 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

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 adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

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

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

I. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
1. Install horizontal suction lines with a uniform slope downward to compressor.
2. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

Q. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

T. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

U. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

## 3.2 PIPE JOINT CONSTRUCTION

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

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

C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints per AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

## 3.3 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.

C. Support multi-floor vertical runs at least at each floor.

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

## 3.5 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
   4. Charge system with a new filter-dryer core in charging line.

## 3.6 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   3. Sheet metal materials.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

B. Related Sections:
   1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2004, Section 6.4.4.2.2 - "Duct Leakage Tests."
   4.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.

6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Lindab Inc.
      b. McGill AirFlow LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than [60 Inches (1524 mm)] <Insert dimension> in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90 (Z275).
   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: G90 (Z275).
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface.

3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL 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 in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) 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: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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 (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM 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, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet (6 m) in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

## 3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Exhaust Ducts: Seal Class C.
   4. Outdoor, Return-Air Ducts: Seal Class A.
   5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

## 3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

## 3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, totaling no less than 25 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

## 3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive 1-inch wg (250 Pa).

2. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Pressure Class: Positive 3-inch wg (750 Pa).
3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive 2-inch wg (500 Pa).

C. Return Air Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Negative 1-inch wg (250 Pa).
2. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Pressure Class: Negative 2-inch wg (500 Pa).
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Negative 2-inch wg (500 Pa).
4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Negative 2-inch wg (500 Pa).

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 1-inch wg (250 Pa).
2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Negative 1-inch wg (250 Pa).
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
   a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
   b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative 2-inch wg (500 Pa).
   e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   f. SMACNA Leakage Class: 3.

E. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Galvanized.
3. Stainless-Steel Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: [Galvanized] [Match duct material].

F. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
   a. Velocity 1000 fpm (5 m/s) or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
   c. Velocity 1500 fpm (7.6 m/s) or Higher:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam or Welded.

G. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Spin in.
   2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
      a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
      b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
      c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 233113

# SECTION 233300 - AIR DUCT ACCESSORIES

## PART 1 - GENERAL

### 1.1 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. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Turning vanes.
5. Flexible connectors.
6. Flexible ducts.
7. Duct accessory hardware.

B. Related Sections:
1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

### 1.3 SUBMITTALS

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

B. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

### 1.4 QUALITY ASSURANCE

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 AMCA 500-D testing for damper rating.

## PART 2 - PRODUCTS

### 2.1 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.

2. American Warming and Ventilating; a division of Mestek, Inc.
3. Duro Dyne Inc.
4. Greenheck Fan Corporation.
5. Ruskin Company.
6. SEMCO Incorporated.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm (10 m/s).

D. Maximum System Pressure: 2-inch wg (0.5 kPa).

E. Frame: 0.052-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch (150-mm) width, 0.050-inch- (1.2-mm-) thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked or Neoprene, mechanically locked.

I. Blade Axles:
1. Material: Stainless steel.
2. Diameter: 0.20 inch (5 mm).

J. Bearings: Steel ball or synthetic pivot bushings.

K. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. 90-degree stops.
4.

## 2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. McGill AirFlow LLC.
   d. METALAIRE, Inc.
   e. Ruskin Company.
2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat-shaped, galvanized-steel channels, 0.064-inch (1.62-mm) minimum thickness.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch (1.62 mm) thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
   a. Oil-impregnated bronze or Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:
1. Size: 1-inch (25-mm) diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.3 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Duro Dyne Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. METALAIRE, Inc.
8. Ruskin Company.

B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
1. Galvanized-steel channels, 0.064 inch (1.62 mm) thick.
2. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 8 inches (200 mm).
2. Opposed-blade design.
3. Galvanized steel.
4. 0.064 inch (1.62 mm) thick.

5. Blade Edging: Closed-cell neoprene edging.

E. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

F. Bearings:
   1. Oil-impregnated bronze.
   2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

## 2.4 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. METALAIRE, Inc.
   4. SEMCO Incorporated.
   5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 36 inches wide and double wall for larger dimensions.

## 2.5 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. Ventfabrics, Inc.
   4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
   2. Tensile Strength: 480 lb f/inch (84 N/mm) in the warp and 360lb f/inch (63 N/mm) in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
   2. Minimum Tensile Strength: 500lb f/inch (88 N/mm) in the warp and 440lb f/inch (77 N/mm) in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
   1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
   2. Tensile Strength: 285 lb f/inch (50 N/mm) in the warp and 185lb f/inch (32 N/mm) in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

## 2.6 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Non-insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   2. Maximum Air Velocity: 4000 fpm (20 m/s).
   3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).

C. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
   1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   2. Maximum Air Velocity: 4000 fpm (20 m/s).
   3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

D. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.
   2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

## 2.7 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.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. Install duct access panels on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. At outdoor-air intakes and mixed-air plenums.
   3. At drain pans and seals.
   4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   6. Upstream from turning vanes.
   7. Upstream or downstream from duct silencers.
   8. Control devices requiring inspection.
   9. Elsewhere as indicated.

H. Access panel sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
   2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
   3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).

4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

I. Label access panels according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

L. Connect diffusers or light troffer boots to ducts directly or with maximum 96 inch lengths of flexible duct clamped or strapped in place.

M. Connect flexible ducts to metal ducts with draw bands.

N. Install duct test holes where required for testing and balancing purposes.

## 3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

# SECTION 233423 - HVAC POWER VENTILATORS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Ceiling-mounting ventilators.
2. In-line centrifugal fans.

### 1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

### 1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Fan speed controllers.

B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

### 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTING VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. American Coolair Corp.
2. Ammerman; General Resource Corp.
3. Breidert Air Products.
4. Broan Mfg. Co., Inc.
5. Carnes Company HVAC.
6. Dayton Electric Manufacturing Co.; a division of W. W. Grainger, Inc.
7. FloAire.
8. Greenheck.
9. JencoFan; Div. of Breidert Air Products.
10. Loren Cook Company.
11. NuTone Inc.
12. Penn Ventilation.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic louvered or eggcrate grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

2.2 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Acme Engineering & Mfg. Corp.

2. American Coolair Corp.
3. Ammerman; General Resource Corp.
4. Bayley Fans; a division of Lau Industries, Inc.
5. Breidert Air Products.
6. Carnes Company HVAC.
7. FloAire.
8. Greenheck.
9. Hartzell Fan, Inc.
10. JencoFan; Div. of Breidert Air Products.
11. Loren Cook Company.
12. Madison Manufacturing.
13. Penn Ventilation.
14. Quietaire Corporation.

B. Description: In-line, direct driven units as indicated on drawing schedule, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[; with wheel, inlet cone, and motor on swing-out service door].

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit, see electrical sections for type requirements

## 2.3 SOURCE QUALITY CONTROL

A. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

## 3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   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.
   6. Adjust damper linkages for proper damper operation.
   7. 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.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

## 3.4 ADJUSTING

A. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Replace fan and motor pulleys as required to achieve design airflow.

C. Lubricate bearings.

END OF SECTION 233423

# SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. Related Sections:
   1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

## PART 2 - PRODUCTS

### 2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A-J Manufacturing Co., Inc.
      b. Anemostat Products; a Mestek company.
      c. Carnes.
      d. Hart & Cooley Inc.
      e. Krueger.
      f. METALAIRE, Inc.
      g. Nailor Industries Inc.
      h. Price Industries.
      i. Titus.
      j. Tuttle & Bailey.
   2. Material: Aluminum.
   3. Finish: Baked enamel, white.
   4. Face Size: as indicated on drawings.
   5. Mounting: T-bar.
   6. Pattern: Fixed, as indicated on drawings.

7. Dampers: Radial opposed blade.
8. Accessories:
   a. Equalizing grid.
   b. Plaster ring.
   c. Sectorizing baffles.
   d. Operating rod extension.

## 2.2 REGISTERS AND GRILLES

A. Fixed Face Register <Insert drawing designation>:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. A-J Manufacturing Co., Inc.
      b. Anemostat Products; a Mestek company.
      c. Carnes.
      d. Dayus Register & Grille Inc.
      e. Hart & Cooley Inc.
      f. Krueger.
      g. Nailor Industries Inc.
      h. Price Industries.
      i. Tuttle & Bailey.
   2. Material: Aluminum
   3. Finish: Baked enamel, white.

## 2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

## 3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements

for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

## 3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

# SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

### 1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

### 1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.
   2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Comfort Aire Div. of Mars Corporation
   2. Carrier Air Conditioning; Div. of Carrier Corporation.
   3. Friedrich Air Conditioning Company.
   4. Lennox Industries Inc.
   5. Trane Company (The); Unitary Products Group.
   6. York International Corp.

2.2 OUTDOOR UNITS (MULTI ZONE SYSTEMS)

**Multi F with LGRED˚** <LMU240HHV>

A. Product Design

The multi zone HVAC system available as a Multi F and Multi F with LGRED˚ system shall be a variable capacity, direct expansion (DX) heat pump engineered system consisting of a single outdoor unit and at least two indoor units. The outdoor unit shall have a single inverter compressor. The outdoor unit shall be connected to multiple indoor units (ducted, non-ducted or mixed type) through a network of piping and control wiring. Each indoor unit shall be capable of providing individual control.

The LG Multi F heat pump system shall be an air cooled system consisting of a single outdoor unit connected to multiple indoor units. All indoor units shall be in the same mode (heating or cooling) at the same time.

The heat pump system will be available in 208/230V, 60Hz, 1 phase.

Operating Conditions

1. The outdoor unit shall be capable of the following ambient operating range

   a. Cooling: 14°F DB to 118°F DB <with optional low ambient kit from -4°F DB to 118°F DB>

   a. Heating: -13°F WB to 75°F WB

General Features

1. Unit shall be manufactured by LG.

The air-conditioning system shall use R410A refrigerant.

The system shall have one air source outdoor unit.

Refrigerant circuit for Multi F with LGRED° <LMU180~300HHV> multiple piping system

The refrigerant circuit shall be field piped to multiple (ducted, non-ducted or mixed) indoor units to effectively and efficiently control the heating or cooling operation of the multi zone system.

All refrigerant piping from outdoor unit to indoor units shall be field insulated.

Factory installed microprocessor controls in the outdoor unit and indoor units shall perform functions to efficiently operate the multi zone system and communicate in a tree configuration from outdoor unit to indoor units via minimum 14 AWG, 4 conductor and stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

Multi F with LGRED° multiple piping system shall have the ability to connect 2 to 3 < LMU240HHV> indoor units.

The system shall be capable of performing continuous operation even when power is turned off to an individual indoor unit.

The outdoor unit shall be internally assembled, wired and piped from the factory.

The factory assembled system shall have the outdoor unit fitted with refrigerant strainer, check valves, oil separator, accumulator < LMU180~300HHV>, 4-way reversing valve, electronic expansion valve(s), high side and low side refrigerant charging ports, and a service port.

Field Supplied Refrigerant Piping Design Parameters

1. The outdoor unit shall be capable of operating at an elevation of 49.2 feet above or below the indoor units.

The outdoor unit shall be capable of operating with up to 246 feet <LMU240HHV> of total equivalent refrigerant piping length.

The outdoor unit shall be capable of operating with up to 82 equivalent feet of refrigerant piping length to the farthest indoor unit.

Defrost Operations

1. The outdoor unit shall be capable of auto defrost operation to melt accumulated ice off the outdoor unit heat exchanger. The defrost cycle control shall be based on outdoor ambient temperatures and outdoor unit heat exchanger temperatures.

The unit shall include a factory installed drain pan heater.

Oil Management

1. The outdoor unit shall have an oil injection mechanism to ensure a consistent film of oil on all moving compressor parts at low speed.

The outdoor unit shall have an oil separator to separate oil mixed with the refrigerant gas during compression and return oil to the compressor.

Fan and Motor Assembly

1. Each outdoor unit shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a horizontal air discharge.

The fan blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material.

The fan(s) shall be equipped with permanently lubricated bearings.

The fan motor(s) shall have variable speed to a maximum of 950 RPM.

The fan(s) shall have a raised guard to help prevent contact with moving parts.

Cabinet

1. The outdoor unit cabinet shall be made of pre-coated metal (PCM).

The front/side panels of the outdoor unit shall be removable type for access to internal components.

Outdoor unit cabinet shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

Outdoor Unit Coil

1. The outdoor unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.

The aluminum fins shall have factory applied corrosion resistant GoldFin™ material.

Coil coating shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

The outdoor unit coil shall be factory tested to a pressure of 600 psig.

The coil for each outdoor unit shall have a minimum of 14 Fins per Inch (FPI).

The coil for each outdoor unit shall have a 2 row heat exchanger.

The outdoor unit cabinet shall have a coil guard.

Compressor(s)

The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 20 Hz to 100 Hz with control in 1 Hz increments.

The compressor shall be mounted on vibration attenuating rubber grommets.

The compressor shall use a factory charge of Polyvinyl Ether (PVE) oil.

The compressor bearing(s) shall have Teflon™ coating.

The compressor shall be equipped with over-current protection.

Operational Sound Levels

1. The outdoor unit shall have sound levels not exceeding 55 dB(A) tested in an anechoic chamber under ISO 3745 standard.

Sensors

1. The outdoor unit shall have

Suction temperature sensor

Discharge temperature sensor

High pressure sensor

Low pressure sensor

Outdoor temperature sensor

Outdoor unit heat exchanger temperature sensor

Wind Load Installations for Outdoor Units

1. Provide Florida wind Load Installation Drawings that meet the requirements of the 2020 Florida Building Code, 7th Edition and ASCE Standard 7-2016 with submittal.

Warranty

1. Limited Warranty Period

STANDARD FIVE (5) YEAR WARRANTY FOR A QUALIFIED SYSTEM - The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending five (5) years after the date of original installation. In absence of proof of installation the warranty date will end five (5) years from the date of manufacture.

ADDITIONAL TWO (2) YEAR COMPRESSOR PART WARRANTY - The Compressor is warranted for an additional two (2) year period after the end of the applicable Standard Part Warranty Period (the "Compressor Warranty Period").

Extended Warranty

The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been (a) installed by a party that has completed the Training Requirements, (b) installation is pursuant to LG's published instructions, and (c) product is registered within 60 days of startup at www.lg-dfs.com or www.lg-dfs-warranty.com.

**Multi F Max with LGRED˚** <LMU480HHV>

A. Product Design

The multi zone Multi F Max with LGRED˚ system shall be a variable capacity, direct expansion (DX) heat pump engineered system consisting of a single outdoor unit and at least two indoor units. The outdoor unit shall have a single inverter compressor. The outdoor unit (Multi F Max) shall be connected to multiple indoor units (ducted, non-ducted or mixed type) through a Branch Distribution Unit (BDU) connected to a network of piping and control wiring. Each indoor unit shall be capable of providing individual control.

The LG Multi F heat pump system shall be an air cooled system consisting of a single outdoor unit connected to multiple indoor units through a Branch Distribution Unit (BDU). All indoor units shall be in the same mode (heating or cooling) at the same time.

The heat pump system will be available in 208/230V, 60Hz, 1 phase.

B. Operating Conditions

1. The outdoor unit shall be capable of the following ambient operating range

Multi F MAX with LGRED° <LMU480HHV>

i. Cooling: 14°F DB to 118°F DB <with optional low ambient kit from -4°F DB to 118°F DB>

Heating: -13°F WB to 75°F DB

General Features

1. Unit shall be manufactured by LG.

The air-conditioning system shall use R410A refrigerant.

The system shall have one air source outdoor unit.

Refrigerant circuit branch distribution piping system

The refrigerant circuit shall be field piped with manufacturer supplied Branch Distribution (BD) unit(s) and Y-branches (if applicable) to multiple (ducted, non-ducted or mixed) indoor units to effectively and efficiently control the heating or cooling operation of the multi zone system.

All refrigerant piping from outdoor unit to BD unit and from BD unit to indoor units shall be field insulated.

Factory installed microprocessor controls in the outdoor unit, BD Unit and indoor units shall perform functions to efficiently operate the multi zone system and communicate in a tree configuration from outdoor unit to BD unit via minimum 14 AWG, and BD unit to indoor units via minimum 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

The Multi F MAX with LGRED° <LMU480HHV> branch distribution piping system shall have the ability to connect 2 to 8 indoor units.

The system shall be capable of performing continuous operation even when power is turned off to an individual indoor unit.

The outdoor unit shall be internally assembled, wired and piped from the factory.

The factory assembled system shall have the outdoor unit fitted with refrigerant strainer, check valves, oil separator, 4-way reversing valve, electronic expansion valve(s), high side and low side refrigerant charging ports, and a service port. The <LMU480HHV> shall include a sub-cooled heat exchanger, vapor injection and vapor bypass circuit.

Field Supplied Refrigerant Piping Design Parameters

1. The outdoor unit shall be capable of operating at an elevation of 98.4 feet above or below the indoor units.

The outdoor unit shall be capable of operating with up to 475 feet of total equivalent refrigerant piping length.

The outdoor unit shall be capable of operating with up to 229.6 equivalent feet of refrigerant piping length to the farthest indoor unit.

The piping length from BD unit to indoor unit shall not exceed 49.2 equivalent feet.

The elevation difference between BD unit and indoor unit, above or below BD unit, shall not exceed 32.8 feet.

The elevation difference between two parallel BD units shall not exceed 49.2 feet.

Defrost Operations

1. The outdoor unit shall be capable of auto defrost operation to melt accumulated ice off the outdoor unit heat exchanger. The defrost cycle control shall be based on outdoor ambient temperatures and outdoor unit heat exchanger temperatures.

The unit shall include a factory installed drain pan heater.

Oil Management

1. The outdoor unit scroll compressor shall utilize a high pressure oil sump to maintain oil quality and pressure differential, not an oil pump, to ensure a consistent film of oil on all moving compressor parts at low speed.

2. The outdoor unit scroll compressor shall have an oil separator and utilize centrifugal oil return to separate oil mixed with the refrigerant gas during compression and return oil to the compressor

Fan and Motor Assembly

1. Each outdoor unit shall be equipped with two direct drive variable speed propeller fans with BLDC motors with a horizontal air discharge.

The fan blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material.

The fan(s) shall be equipped with permanently lubricated bearings.

The fan motor(s) shall have variable speed to a maximum of 750 RPM.

The fan(s) shall have a raised guard to help prevent contact with moving parts.

Cabinet

1. The outdoor unit cabinet shall be made of pre-coated metal (PCM).

The front/side panels of the outdoor unit shall be removable type for access to internal components.

Outdoor unit cabinet shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

Outdoor Unit Coil

1. The outdoor unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.

The aluminum fins shall have factory applied corrosion resistant GoldFin™ material.

Coil coating shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

The outdoor unit coil shall be factory tested to a pressure of 600 psig.

The coil for each outdoor unit shall have a minimum of 14 Fins per Inch (FPI).

The coil for each outdoor unit shall have a 3 row heat exchanger.

The coil for the outdoor unit shall have a vapor bypass circuit to separate gas refrigerant and return it to the compressor suction.

The outdoor unit cabinet shall have a coil guard.

Compressor(s)

1. The outdoor unit shall be equipped with one hermetically sealed, digitally controlled, inverter driven scroll compressor with suction inlet directly into the compression chamber.

   The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 10 Hz to 150 Hz with control in 1 Hz increments.

   The compressor for the outdoor unit shall include vapor injection.

   The compressor shall be mounted on vibration attenuating rubber grommets.

   The compressor shall use a factory charge of Polyvinyl Ether (PVE) oil.

   The compressor bearing(s) shall have Teflon™ coating.

   The compressor shall be equipped with over-current protection.

Operational Sound Levels

1. The outdoor unit shall have sound levels not exceeding 56 dB(A) tested in an anechoic chamber under ISO 3745 standard.

Sensors

1. The outdoor unit shall have

   Suction temperature sensor

   Discharge temperature sensor

   High pressure sensor

   Low pressure sensor

   Outdoor temperature sensor

   Outdoor unit heat exchanger temperature sensor

Wind Load Installations for Outdoor Units

1. Provide Florida wind Load Installation Drawings that meet the requirements of the 2020 Florida Building Code, 7th Edition and ASCE Standard 7-2016 with submittal.

Warranty

1. Limited Warranty Period

   STANDARD FIVE (5) YEAR WARRANTY FOR A QUALIFIED SYSTEM - The Part(s) of a qualified System, including the compressor, are warranted for a period (the “Standard Parts Warranty Period”) ending five (5) years after the date of original installation. In absence of proof of installation the warranty date will end five (5) years from the date of manufacture.

   ADDITIONAL TWO (2) YEAR COMPRESSOR PART WARRANTY - The Compressor is warranted for an additional two (2) year period after the end of the applicable Standard Part Warranty Period (the “Compressor Warranty Period”).

Extended Warranty

The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been (a) installed by a party that has completed the Training Requirements, (b) installation is pursuant to LG's published instructions, and (c) product is registered within 60 days of startup at www.lg-dfs.com or www.lg-dfs-warranty.com.

**PRODUCT(S) - Branch Distribution Unit (Multi F Max Systems Only)** <PMBD3620> <PMBD3630><PMBD3640><PMBD3641>

A. Operating Range

The BD unit shall be capable of the following ambient operating range

0°F DB to 150°F DB

General

1. BD unit is designed for the use with Multi F MAX with LGRED° <LMU480HHV> outdoor units as manufactured by LG.

BD unit casing shall be galvanized steel.

BD unit shall require 208-230V/1-phase/60Hz power supply.

BD Unit shall be an intermediate refrigerant control device between the outdoor unit and the indoor units to effectively and efficiently control the heating or cooling operation of the Multi F MAX system.

BD unit shall have a two pipe system comprising of

Vapor pipe

Liquid Pipe

BD unit shall have 2, 3 or 4 ports.

Port capacity for <PMBD3620~PMBD3640> BD Units

Each port shall connect to 1 indoor unit for a maximum nominal capacity of 24MBh.

Port capacity for <PMBD3641> BD Unit

Ports A~C shall each connect to 1 indoor unit for a maximum nominal capacity of 24MBh.

Port D shall connect to 1 indoor unit for a nominal capacity of 24Mbh **or** 36MBh.

Maximum nominal capacity per BD unit shall not exceed 73MBh.

BD unit shall be internally piped, wired, assembled and run tested at the factory.

BD unit shall be designed for indoor installation.

BD unit shall have 2 two-positioned solenoid valves per port.

BD unit shall not require a condensate drain.

BD unit shall be internally insulated.

All field refrigerant lines from outdoor unit to BD unit and from BD unit to indoor units shall be field insulated.

BD unit shall not exceed a net weight of 16 lbs.

Two BD units shall be capable of being piped in parallel using an accessory Y-branch kit.

Controls

1. BD unit shall have factory installed control boards and integral microprocessor to communicate with the main control board in the outdoor unit.

BD unit shall be connected to the outdoor unit and indoor units in a power/control circuit from outdoor units and to Indoor units using a minimum 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

BD unit may be connected to optional field supplied and field installed isolation valves to isolate the BD unit for servicing without evacuating the entire system.

Warranty

1. Limited Warranty Period

STANDARD FIVE (5) YEAR WARRANTY FOR A QUALIFIED SYSTEM - The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending five (5) years after the date of original installation. In absence of proof of installation the warranty date will end five (5) years from the date of manufacture.

ADDITIONAL TWO (2) YEAR COMPRESSOR PART WARRANTY - The Compressor is warranted for an additional two (2) year period after the end of the applicable Standard Part Warranty Period (the "Compressor Warranty Period").

Extended Warranty

The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been (a) installed by a party that has completed the Training Requirements, (b) installation is pursuant to LG's published instructions, and (c) product is registered within 60 days of startup at www.lg-dfs.com or www.lg-dfs-warranty.com.

## 2.3 OUTDOOR UNITS (SINGLE ZONE SYSTEMS)

**Single Zone with LGRED° Heat Pump Outdoor Unit (Cassette/Ducted/VAHU)**
<LUU180HHV><LUU240HHV><LUU360HHV><LUU420HHV><LUU480HHV>

Operating Conditions

The outdoor unit shall be capable of the following ambient operating range.

<LUU180HHV><LUU240HHV><LUU360HHV><LUU420HHV><LUU480HHV>

Cooling: 5°F DB to 118°F DB <with optional low ambient kit from -4°F DB to 118°F DB>

i. Heating: -13°F WB to 64°F WB

B. General

1. Unit shall be manufactured by LG.

The air-conditioning system shall use R410A refrigerant.

Each system shall have one air source outdoor unit.

The refrigerant circuit shall be field piped to a single matching indoor unit to effectively and efficiently control the heating or cooling operation of the system.

All refrigerant piping from outdoor unit to indoor unit shall be field insulated.

Factory installed microprocessor controls in the outdoor unit and indoor unit shall perform functions to efficiently operate the single zone system and communicate via minimum 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

The outdoor unit shall be internally assembled, wired and piped from the factory.

The factory assembled system shall have the outdoor unit fitted with refrigerant strainer, check valves, oil separator, accumulator, 4-way reversing valve, electronic expansion valve, high side and low side refrigerant charging ports, and a service port.

The outdoor unit <LUU420HHV> <LUU480HHV>shall include a sub cooler, vapor injection valve and vapor bypass circuit.

C. Piping capabilities

1. The outdoor unit shall be capable of operating at an elevation of 98.4 feet <LUU180HHV><LUU240HHV><LUU360HHV><LUU420HHV><LUU480HHV> above or below the indoor unit.

The outdoor unit shall be capable of operating with up to 164 feet <LUU180HHV><LUU240HHV> or 246 feet <LUU360HHV><LUU420HHV> <LUU480HHV> of total equivalent refrigerant piping length.

D. Defrost Operations

1. The outdoor unit shall be capable of auto defrost operation to melt accumulated ice off the outdoor unit heat exchanger. The defrost cycle control shall be based on outdoor ambient temperatures and outdoor unit heat exchanger temperatures.

Factory installed base pan heater shall be included for <LUU180HHV><LUU240HHV><LUU360HHV><LUU420HHV><LUU480HHV> outdoor units.

E. Oil Management

1. The outdoor unit shall have an oil injection mechanism to ensure a consistent film of oil on all moving compressor parts at low speed.

The outdoor unit shall have an oil separator to separate oil mixed with the refrigerant gas during compression and return oil to the compressor.

F. Cabinet

1. The outdoor unit cabinet shall be made of pre-coated metal (PCM).

The front/side panels of the outdoor unit shall be removable type for access to internal components.

Outdoor unit cabinet shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

G. Fan Assembly

1. Each 1-1/2 to 2 ton outdoor unit <LUU180HHV><LUU240HHV> shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a horizontal air discharge.

Each 3 to 4 ton outdoor unit <LUU360HHV><LUU420HHV><LUU480HHV> shall be equipped with two direct drive variable speed propeller fans with BLDC motors with a horizontal air discharge.

The fan blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material.

The fan(s) shall be equipped with permanently lubricated bearings.

The fan motor(s) shall have variable speed to a maximum of 800 RPM.

The fan(s) shall have a raised guard to help prevent contact with moving parts.

H. Outdoor Coil

1. Variable Path Heat Exchanger

a) System <LUU420HHV><LUU480HHV> shall have a variable flow path and outdoor heat exchanger function to vary the refrigerant flow volume and path. Control of the variable path circuits shall be based on system operating mode and operating conditions as targeted to manage the coil heat transfer capacity and efficiency.

b) The variable path heat exchanger technology shall be provided to maintain stable refrigeration cycle operation during mild weather conditions and maintain a robust hot vapor temperature system head pressure that delivers “gas-furnace leaving air temperature” from the indoor unit at sub-zero outdoor air temperature down to minus (-) 13°F.

The aluminum fins shall have factory applied corrosion resistant GoldFin™ material.

Coil coating shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

The outdoor unit coil shall be factory tested to a pressure of 600 psig.

The coil for each outdoor unit shall have a minimum of 14 Fins per Inch (FPI).

The coil for each outdoor unit shall have a 2 row heat exchanger.

The outdoor unit cabinet shall have a coil guard.

I. Compressor

2. The outdoor <LUU180HHV><LUU240HHV><LUU360HHV><LUU420HHV><LUU480HHV> unit shall be equipped with one hermetically sealed, digitally controlled, inverter driven R1 scroll compressor.

The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 10 Hz to 95 Hz (cooling), 10Hz to 130Hz (heating) <LUU180HHV><LUU240HHV>, with control in 1 Hz increments.

The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 15 Hz to 120 Hz (cooling), 15Hz to 135Hz (heating) <LUU360HHV> with control in 1 Hz increments.

The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 10 Hz to 120 Hz (cooling), 10Hz to 135Hz (heating) <LUU420HHV><LUU480HHV>, with control in 1 Hz increments.

3. The outdoor <LUU420HHV><LUU480HHV> unit shall have a medium pressure gas vapor injection function employed in the heating and cooling modes to increase system capacity when the outdoor ambient temperatures are low and lower compressor lift when temperatures are high. The compressor vapor injection flow amount shall be controlled by the vapor injection sub-cooling algorithm reset by discharge gas temperatures of the compressor.

The compressor shall be mounted on vibration attenuating rubber grommets.

The compressor shall use a factory charge of Polyvinyl Ether (PVE) oil.

The compressor bearing(s) shall have Teflon™ coating.

The compressor shall be equipped with over-current protection.

Standard, non-inverter driven compressors shall not be permitted nor shall a compressor without vapor injection or direct sump oil return capabilities.

J. Sound Levels

1. The outdoor unit shall have sound levels not exceeding 56 dB(A) tested in an anechoic chamber under ISO 3745 standard.

1. A field setting shall be available to program the outdoor unit to reduce sound levels at night, when desired, to a selectable level while still able to meet building load requirement. This mode is available in both cooling and heating modes.

K. Sensors

1. The outdoor unit shall have

Suction temperature sensor

Discharge temperature sensor

High pressure sensor

Low Pressure sensor

Outdoor temperature sensor

Outdoor unit heat exchanger temperature sensor

Vapor injection inlet temperature sensor <LUU420HHV><LUU480HHV>

Vapor injection outlet temperature sensor<LUU420HHV><LUU480HHV>

L. Wind Load Installations for Outdoor Units

2. Provide Florida wind Load Installation Drawings that meet the requirements of the 2017 Florida Building Code, 6th Edition and ASCE Standard 7-2010 with submittal.

M. Warranty

3. Limited Warranty Period

STANDARD FIVE (5) YEAR WARRANTY FOR A QUALIFIED SYSTEM - The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending five (5) years after the date of original installation. In absence of proof of installation the warranty date will end five (5) years from the date of manufacture.

ADDITIONAL TWO (2) YEAR COMPRESSOR PART WARRANTY - The Compressor is warranted for an additional two (2) year period after the end of the applicable Standard Part Warranty Period (the "Compressor Warranty Period").

Extended Warranty

a) The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been (a) installed by a party that has completed the Training Requirements, (b) installation is pursuant to LG's published instructions, and (c) product is registered within 60 days of startup at www.lg-dfs.com or www.lg-dfs-warranty.com.

## 2.4 SINGLE ZONE WITH LGRED HEAT PUMP INDOOR UNIT (DUCTED-VAHU)

<LVN181HV4><LVN241HV4> <LVN361HV4><LVN420HV><LVN480HV>

Operating Conditions

The indoor unit shall be capable of the following ambient operating range.

Cooling: 57°F WB to 77°F WB

Heating: 59°F DB to 81°F DB

A. General:

1. Unit shall be manufactured by LG.

Unit shall be factory assembled, wired, piped and run tested.

Unit shall be designed to be installed for indoor application.

Unit shall be designed to mount fully concealed behind the wall, in a closet or above the finished ceiling.

The unit case shall be designed to accept an internal, optional LG electric strip heater mounted in the reheat position, available in 3, 5, 8, 10 kW <LVN181HV4><LVN241HV4><LVN361HV4>; 3, 5, 8, 10, 15, 20 kW <LVN420HV><LVN480HV> for field installation per installation instructions.

The supply air shall be flanged for field installed ductwork that shall not exceed the external static pressure limitation of the unit.

Unit shall bear the ETL mark.

B. Casing/Panel

2. Unit case shall be manufactured using 22-gauge Pre Coated Metal (PCM).

The external surface shall be finished with a high gloss baked enamel finish.

The finish color shall be morning fog.

The cold surfaces of the unit shall be internally insulated with 1/2 inch foil faced polystyrene fiber insulation.

The inside surface of fan assembly door access panel shall be treated with 1/2 inch polystyrene fiber insulation, encapsulated on both sides.

The access panel shall be sealed along the edges with reinforced foil faced covering to prevent deterioration caused by panel removal.

All the access panels shall be provided with gasket seals to minimize air leakage.

The external insulation shall be plenum rated and conform to ASTM Standard D-1418.

C. Cabinet Assembly

3. The unit shall be designed to operate in the vertical (up flow and down flow) configuration and horizontal (left and right) end discharge. Down flow configuration shall require an optional kit.

Unit shall, in the vertical position, have opening for supply air from top (or bottom) with a dedicated bottom (or top) vertical return and in the horizontal position supply air shall be from the left (or right) end with the return air from the right (or left) end.

The <LVN---HV4> unit shall be designed to operate in the vertical (up flow and down flow) configuration and horizontal (left and right) end discharge. Down flow configuration shall require an optional kit.

Unit shall, in the vertical position, have opening for supply air from top (or bottom) with a dedicated bottom (or top) vertical return and in the horizontal position supply air shall be from the left (or right) end with the return air from the right (or left) end.

Unit shall be equipped with factory installed temperature thermistors for:

Return air

Refrigerant entering coil

Refrigerant leaving coil

Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.

Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.

Unit shall have the following functions as standard:

Self-diagnostic function

Auto changeover function (Single zone systems only)

Auto operation function

Dehumidifying function

Child lock function

Hot start

Dual thermistor control

Sleep mode

External static pressure (ESP) control

Aux heater applications

D. Fan Assembly:

4. The unit shall have an integral fan assembly consisting of galvanized steel housing and forward curve fan wheel.

The fan motor shall be Electronically Commutated Motor (ECM) <LVN181HV4><LVN241HV4><LVN361HV4>; and Brushless Digitally commutated (BLDC) <LVN420HV><LVN480HV> with permanently lubricated and sealed ball bearings.

The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm.

In cooling mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.

In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.

The Auto fan setting shall adjust the fan speed to most effectively achieve the set-point.

The ECM fan<LVN181HV4><LVN241HV4><LVN361HV4> shall adjust and deliver constant airflow regardless of permitted external static pressure.

The BLDC fan settings <LVN420HV><LVN480HV> can be field adjusted from the factory setting (RPM/ESP)

Unit <LVN420HV> <LVN480HV> manufactured starting October 2020, shall have Auto ESP Control to adjust and deliver constant airflow regardless of permitted external static pressure

The unit <LVN181HV4><LVN241HV4><LVN361HV4> shall be designed for high speed air volume against an external static pressure of up to 0.7” water gauge.

The unit <LVN420HV><LVN480HV> shall be designed for high speed air volume against an external static pressure of up to 1.0” water gauge.

E. Filter Assembly:

5. The unit shall be supplied with a filter rack capable of accepting a field supplied 16” x 20” x 1” filter cartridge <LVN181HV4><LVN241HV4><LVN361HV4> and a filter rack capable of accepting a field supplied 24” x 20” x 1” filter cartridge <LVN420HV><LVN480HV>.

The filter rack shall be equipped with guides to keep filter centered in the rack.

The filter access shall be from the front of the unit without removing coil or fan area access panel.

The filter access door shall be fitted with thumb screws that can be removed without the use of any tool.

F. Coil Assembly

6. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.

The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.

Unit shall have minimum two row coil, 18 fins per inch.

Unit shall have a factory supplied condensate drain pan below the coil constructed of HIPS (high impact polystyrene resin).

Unit shall be designed for gravity drain.

The unit shall have a secondary drain port plug for overflow.

Unit shall have provision of 45° flare refrigerant pipe connections.

The coil shall be factory pressure tested at a minimum of 550 psig.

All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately. Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.

G. Microprocessor Control

7. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system.

The unit shall be able to communicate with the outdoor unit using a field supplied minimum of 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

Central control shall be available through an optional control board for the outdoor unit.

Group control shall be available to allow multiple indoor units to operate from a single controller, or allow connection of more than one controller to an indoor unit.

The unit controls shall operate the indoor unit using one of the five operating modes:

Auto operation

Heating

Cooling

Dry

Fan only

8. The units <LVN181HV4><LVN241HV4> <LVN361HV4> shall have provision for W-2 terminal connection for second stage heat.

The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.

The unit shall be able to operate with the fan turned off during system cooling thermal off.

The unit shall be able to operate with a continuous fan setting.

H. Electrical:

9. The unit electrical power shall be 208-230/1/60 (V/Ph/Hz).

The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

I. Controls:

10. The indoor unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently.

An optional wireless handheld controller shall be available as an additional accessory for use with installed LG wired controller.

The indoor unit shall have a built-in interface for 3rd party thermostats.

The indoor unit shall accommodate an optional Wi-Fi module as an additional accessory to allow monitoring and control through a smart device with the LG Smart ThinQ© application.

J. Warranty

11. Please refer to the respective outdoor unit for applicable warranty.

## 2.5 SINGLE ZONE HEAT PUMP INDOOR UNIT (CASSETTE- 4WAY)

<LCN128HV4>

Operating Conditions

The indoor unit shall be capable of the following ambient operating range.

Cooling: 57°F WB to 77°F WB

Heating: 59°F DB to 81°F DB

N. General

2. Unit shall be manufactured by LG.

Unit shall be factory assembled, wired, piped and run tested.

Unit shall be designed to be installed for indoor application.

Unit shall be designed to mount recessed in the ceiling and has a surface mounted concentric grille on the bottom of the unit.

O. Casing/Panel

3. Unit case shall be manufactured using galvanized steel plate.

The unit shall be provided with an off-white Acrylonitrile Butadiene Styrene (ABS) polymeric resin architectural grille.

The grille shall have a tapered trim edge, and a hinged, spring clip (screw-less) return air filter-grille door.

Unit shall be provided with metal ears designed to support the unit weight on four corners.

Ears shall have pre-punched holes designed to accept field supplied all thread rod hangers.

P. Cabinet Assembly

4. Unit shall have four supply air outlets and one return air inlet.

The supply air outlet shall be through four-directional slot diffusers each equipped with independent oscillating motorized guide vane designed to change the airflow direction.

The grille shall have a discharge range of motion of 40° in an up/down direction with capabilities of locking the vanes.

The unit shall have a guide vane algorithm designed to sequentially change the predominant discharge airflow direction in counterclockwise pattern.

Guide vanes shall provide airflow in all directions.

Unit shall be equipped with factory installed temperature thermistors for

Return air

Refrigerant entering coil

Refrigerant leaving coil

Unit shall have a built-in control panel to communicate with the outdoor unit.

The unit shall have provision for fresh air ventilation through a knock-out on the cabinet.

The unit shall have factory designated branch duct knockouts on the unit case.

The branch duct knockouts shall have the ability to duct up to half of the unit airflow capacity.

The branch duct shall be ducted within the same room as the indoor unit.

Unit shall have the following functions as standard

Self-diagnostic function

Auto restart function

Auto changeover function

Dehumidifying function

Forced operation

Hot Start

Sleep mode

Q. Fan Assembly

5. The unit shall have a single direct driven turbo fan.

The fan shall be made of high strength ABS HT-700 polymeric resin.

The fan motor is Brushless Digitally controlled (BLDC) with permanently lubricated and sealed ball bearings.

The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.

The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm.

In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Power Cool, and Auto.

In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.

The Auto fan setting shall adjust the fan speed to most effectively achieve the set-point.

Unit shall have factory installed motorized louvers to provide flow of air in up and down direction for uniform airflow.

R. Filter Assembly

6. The return air inlet shall have a factory supplied 14” x 14” x 1” primary removable, washable filter.

The filter access shall be from the bottom of the unit.

S. Coil Assembly

7. Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.

Unit shall have minimum of 2 rows of coils.

Unit shall have a factory supplied condensate drain pan below the coil.

Unit shall have an installed and wired condensate drain pump capable of providing minimum 27.5inch lift from bottom surface of the unit.

The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan.

Unit shall have provision of 45° flare refrigerant pipe connections.

The coil shall be factory pressure tested at a minimum of 551 psig.

All refrigerant piping from outdoor unit to indoor unit shall be field insulated.

T. Microprocessor Control

8. The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system.

The unit shall be able to communicate with the outdoor unit using a field supplied minimum of 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

Central control shall be available through an optional control board for the outdoor unit.

Group control shall be available to allow multiple indoor units to operate from a single controller, or allow connection of more than one controller to an indoor unit.

The unit controls shall operate the indoor unit using one of the five operating modes:

Auto changeover

Heating

Cooling

Dry

Fan only

U. Electrical

9. The unit electrical power shall be 208-230/1/60 (V/Ph/Hz)

The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.

V. Controls

10. The indoor unit shall be supplied with a wireless handheld controller.

An optional wired controller shall be available as an additional accessory.

The indoor unit shall accommodate an optional Wi-Fi module as an additional accessory to allow monitoring and control through a smart device with the LG Smart ThinQ© application.

W. Warranty

11. Please refer to the respective outdoor unit for applicable warranty.

## 2.6 SINGLE ZONE HEAT PUMP OUTDOOR UNIT

<LUU127HV>

Operating Conditions

The outdoor unit shall be capable of the following ambient operating range.

a. Cooling: 0°F DB to 118°F DB <with optional low ambient kit from -4°F DB to 118°F DB>

b. Heating: -4°F WB to 64°F WB

X. General

12. Unit shall be manufactured by LG.

The air-conditioning system shall use R410A refrigerant.

Each system shall have one air source outdoor unit.

The refrigerant circuit shall be field piped to a single matching indoor unit to effectively and efficiently control the heating or cooling operation of the system.

All refrigerant piping from outdoor unit to indoor unit shall be field insulated.

Factory installed microprocessor controls in the outdoor unit and indoor unit shall perform functions to efficiently operate the single zone system and communicate via minimum 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

The outdoor unit shall be internally assembled, wired and piped from the factory.

The factory assembled system shall have the outdoor unit fitted with refrigerant strainer, check valves, oil separator, accumulator, 4-way reversing valve, electronic expansion valve, high side and low side refrigerant charging ports, and a service port.

Y. Piping capabilities

13. The outdoor unit shall be capable of operating at an elevation of 49.2 feet above or below the indoor unit.

The outdoor unit shall be capable of operating with up to 66 feet of total equivalent refrigerant piping length.

Z. Defrost Operations

14. The outdoor unit shall be capable of auto defrost operation to melt accumulated ice off the outdoor unit heat exchanger. The defrost cycle control shall be based on outdoor ambient temperatures and outdoor unit heat exchanger temperatures.

An optional base pan heater shall be available for 9/12MBH outdoor units manufactured after 2/1/2018 and 18MBH+ outdoor units manufactured after 4/1/2017.

AA. Oil Management

15. The outdoor unit shall have an oil injection mechanism to ensure a consistent film of oil on all moving compressor parts at low speed.

The outdoor unit shall have an oil separator to separate oil mixed with the refrigerant gas during compression and return oil to the compressor.

BB. Cabinet

16. The outdoor unit cabinet shall be made of pre-coated metal (PCM).

The front/side panels of the outdoor unit shall be removable type for access to internal components.

Outdoor unit cabinet shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

CC. Fan Assembly

17. The outdoor unit shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a horizontal air discharge.

The fan blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material.

The fan(s) shall be equipped with permanently lubricated bearings.

The fan motor(s) shall have variable speed to a maximum of 950 RPM.

The fan(s) shall have a raised guard to help prevent contact with moving parts.

DD. Outdoor Coil

18. The outdoor unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.

The aluminum fins shall have factory applied corrosion resistant GoldFin™ material.

Coil coating shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

The outdoor unit coil shall be factory tested to a pressure of 600 psig.

The coil for each outdoor unit shall have a minimum of 14 Fins per Inch (FPI).

The coil for each outdoor unit shall have a 2 row heat exchanger.

The outdoor unit cabinet shall have a coil guard.

EE. Compressor

19. The outdoor unit shall be equipped with one hermetically sealed, digitally controlled, inverter driven twin-rotary compressor.

The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 20 Hz to 100 Hz with control in 1 Hz increments.

The compressor shall be mounted on vibration attenuating rubber grommets.

The compressor shall use a factory charge of Polyvinyl Ether (PVE) oil.

The compressor bearing(s) shall have Teflon™ coating.

The compressor shall be equipped with over-current protection.

FF. Sound Levels

20. The outdoor unit shall have sound levels not exceeding 54 dB(A) tested in an anechoic chamber under ISO 3745 standard.

GG. Sensors

21. The outdoor unit shall have

Suction temperature sensor

Discharge temperature sensor

High pressure sensor

Low Pressure sensor

Outdoor temperature sensor

Outdoor unit heat exchanger temperature sensor

HH. Wind Load Installations for Outdoor Units

22. Provide Florida wind Load Installation Drawings that meet the requirements of the 2017 Florida Building Code, 6th Edition and ASCE Standard 7-2010 with submittal.

II. Warranty

1. Limited Warranty Period

STANDARD FIVE (5) YEAR WARRANTY FOR A QUALIFIED SYSTEM - The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending five (5) years after the date of original installation. In absence of proof of installation the warranty date will end five (5) years from the date of manufacture.

ADDITIONAL TWO (2) YEAR COMPRESSOR PART WARRANTY - The Compressor is warranted for an additional two (2) year period after the end of the applicable Standard Part Warranty Period (the "Compressor Warranty Period").

Extended Warranty

The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been (a) installed by a party that has completed the Training Requirements, (b) installation is pursuant to LG's published instructions, and (c) product is registered within 60 days of startup at www.lg-dfs.com or www.lg-dfs-warranty.com..

2.7 ACCESSORIES

STANDARD III WIRED REMOTE CONTROLLER: PREMTB100

**A. Overview:**

The LG Standard III Wired Remote Controller shall be capable of controlling up to sixteen indoor units (one group) as a single zone. The LG Standard III Wired Remote Controller shall be capable of monitoring and controlling the group in terms of on/off, mode of operation, airflow direction, fan speed, space temperature, and space temperature set point based on the available functions of the connected system. Additionally, the LG Standard III Wired Remote Controller shall be capable of providing programmable scheduling of occupied/unoccupied settings, on/off, mode of operation, set point and fan speed. The LG Standard III Wired Remote Controller shall have one Digital Output (12VDC) for external equipment control.

**B.** GENERAL:

1. The LG Standard III Wired Remote Controller shall be compatible with LG indoor units.
2. The LG Standard III Wired Remote Controller shall have a backlit LCD display with screensaver capability.
3. The LG Standard III Wired Remote Controller shall have an internal time clock and calendar.
4. The LG Standard III Wired Remote Controller shall be able to control two set point auto operation of indoor units. (Model dependent.)
5. The LG Standard III Wired Remote Controller shall be able to display temperature in °F or °C based on user settings.
6. The LG Standard III Wired Remote Controller shall be able to monitor and control up to sixteen indoor units (one group) as a single zone.
7. Up to two LG Standard III Wired Remote Controllers shall be connectable to a single group and operate in a main/sub configuration.
8. The LG Standard III Wired Remote Controller shall be able to limit the temperature set point range for heating and cooling modes.

**C.** BASIC FUNCTIONS:

| Function | Description | Monitor | Control |
|---|---|---|---|
| On/Off | On/Off operation for group | X | X |
| Mode of Operation | Mode of operation for group (Heat/Cool/Fan/Dry/Auto) | X | X |

| | | | |
|---|---|---|---|
| Set Point | Space temperature set point for group setting. Setting temperature range 64°F to 84°F. Separate heat/cool set point settings for auto mode.<br><br>*Set Point ranges dependent on operation mode and connected equipment. | X | X |
| Space Temperature, and Humidity | Display measured space temperature, and Humidity | X | |
| Ventilation Mode | Compatible with ERV for Ventilation mode | X | X |
| Fan Speed | Select fan speeds Hi-Mid1-Mid2-Low-Auto | X | X |
| Airflow Direction | Select air direction settings Auto/Swing/Fixed | X | X |
| Static Pressure Control | Ability to adjust static pressure control with Function setting. | X | X |
| Lock setting | Ability to lock out controller operation | X | X |
| Filter check | Notification to change dirty filter | X | |
| Auto Restart | Auto Restart capabilities upon power failure | X | X |

**Available functions/features may differ based on connected system.**

**D. Advanced Functions:**

| Function | Description | Monitor | Control |
|---|---|---|---|
| Schedule | Schedule control of Occupied\Unoccupied, On\Off, Mode, Setpoints, and Fan Speed | X | X |
| Two Setpoint Auto Changeover | Heat Recovery systems, minimum difference between setpoints (0-10°F) Adjustable Dead band | X | X |
| Home\Leave setting | For Temporary Unoccupied Status | X | X |
| Sub-Function Setting | Ability to turn on/off the sub-functions supported by the IDU. | X | X |
| Ap Mode Setting | Ability to pair the IDU with the Wi-Fi Modem (Internal with all wall mount IDUs- Accessory with ducted and other IDUs) | X | X |
| Energy Use Display | Display actual operational time and estimated power consumption | X | |
| Operation Time Limit | Limit the run time of an indoor unit (30-540 minutes) | X | X |
| Time/Date | Display current time and date | X | X |
| Auxiliary Heat Control | Ability to control up to two additional heat sources according to the internal IDU logic. | X | X |

| | | | |
|---|---|---|---|
| External Equipment Control | Ability to control external equipment with one internal digital output (12VDC) | X | X |
| Elevation Grille | Operate elevation grille for indoor unit filter cleaning | X | X |
| Error Code | Display code upon an indoor unit malfunction | X | |

**Available functions/features may differ based on connected system.**

**E. Electrical:**

1. The remote controller shall be powered via the indoor unit remote controller communication bus. Power shall be 12 VDC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Water Coil Connections: Comply with requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

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

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply[ and return] ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[, test, and adjust] field-assembled components and equipment installation, including connections[, and to assist in field testing]. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

## 3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

## 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238126

SECTION 260500 – GENERAL REQUIREMENTS

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 DESCRIPTION OF WORK INCLUDED

A. General Requirements:
   1. All items of labor, materials and equipment, not specified in detail or shown on drawings but necessary for complete installation and proper operation of work described or implied, shall be furnished and installed.
   2. Test all electrical conductors, after completion of installation of wiring and apparatus, to insure continuity, proper splicing, freedom from grounds, except "made grounds" and those required for protection and insulation resistance. Use testing instruments, i.e. megger. Activation of each circuit will be required as final test. Testing shall be done at no additional expense to the Owner.
   3. Drawings are indicative of work to be installed but do not indicate all bends, fittings, boxes, etc. that will be required in this Contract. The structural and finished conditions of the project shall be investigated prior to construction.
   4. Coordinate work with other trades to avoid interference between piping, ducts, equipment, architectural or structural features. In case of interference, the Architect decides which work is to be relocated, regardless of which is first installed.
   5. All equipment pads located in areas receiving a floor finish (i.e.: tile, paint) shall be painted. Type of paint shall be approved for concrete application. Color to be selected by Architect.
   6. Visit the site to determine actual conditions. No extra compensation will be allowed by failure to determine existing conditions.

1.3 QUALITY ASSURANCE

A. Regulations, Standards and Publications;
   1. NEC National Electrical Code of National Fire Protection Association
   2. ASTM American Society for Testing and Materials
   3. UL Underwriter's Laboratories
   4. ICEA Insulated Cable Engineers Association
   5. NEMA National Electrical Manufacturers Association
   6. IEEE Institute of Electrical and Electronic Engineers
   7. ANSI American National Standards Institute, Inc.
   8. ISA Instrument Society of America
   9. NESC National Electrical Safety Code
   10. ADA Americans with Disabilities Act
   11. IBC International Building Council

B. The installation must comply with all Federal and State, municipal or other authority's laws, rules and/or regulations.

C. Inspections by the required authorities shall be made. Original final wiring certificates with two copies shall be submitted to the Architect, at no additional cost to Owner.

D. The electrical inspections shall be made by the Middle Department Inspection Agency or other inspecting service reviewed by the Architect.

E. All electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the Underwriters' Laboratory. All control panels, motor control center PLC sections, etc. shall bear the UL-508A listing. All complete assemblies shall be UL listed.

F. All electrical equipment or apparatus of any one system shall be of the same quality as produced by one or more manufacturers, suitable for use in a unified system. The term "manufacturer" shall be understood as applying to a reputable firm who assumes full responsibility for its products.

G. Qualification:
   1. When more than one name of manufacturer is listed in these specifications, the first manufacturer and number determine the style and quality.

## 1.4 SUBMITTALS

A. General:
   1. Submit in accordance with Division 01 Specification

B. Shop Drawings:
   1. All shop drawings shall be submitted to the Architect for review. If incorrect, they shall be resubmitted in quantity according to Contract conditions until satisfactory. Work shown on shop drawings shall not be executed until such drawings are approved.
   2. All shop drawing submittals shall clearly indicate, using arrows and/or highlighting on all copies, which item(s) are being submitted and that each item being submitted is in compliance with all requirements on the drawings and in these specifications. All pertinent specification and drawing requirements shall be indicated on the manufacturer's drawings.
   3. See specific section for further breakdown of shop drawing items.
   4. Submit certification with shop drawing submittals that all equipment is UL listed.
   5. Shop drawings shall indicate adequate clearance for operation, maintenance and replacement of operating equipment devices.

C. Samples:
   1. A sample board shall be furnished and installed (construction shed) consisting of samples of all wiring devices, conduits, conductors, floor boxes, floor service fittings, disconnect switches, wall plates and any other item required by the Architect.
   2. All items may be removed from the board and used in the construction of the building.

## 1.5 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Product Handling:
   1. Deliver all materials in good condition; store in dry place, off ground, and keep dry at all times.

B. Protection of Installation:
   1. All unfinished installations, construction materials and equipment shall be protected during construction.

PART 2 - PRODUCTS

2.1 SEE SPECIFIC SECTIONS FOR PRODUCTS

PART 3 - EXECUTION

3.1 INSTALLATION

A. Protection of Installation:
   1. All equipment shall be protected during construction.
   2. All damaged equipment caused by noncompliance with this requirement shall be repaired at no expense to the Owner.

B. Openings and Chases:
   1. Determine locations of chases and openings prior to construction so that same may be provided where required.
   2. If openings or chases are made after building construction is accomplished, such cutting and repairing of the building shall be made by this Contractor in complete coordination with other trades on the job site to match original conditions in quality, color and type of materials used, and at no additional expense to the Owner.

C. Position of Outlets:
   1. The Architect shall determine the position of all relocated outlets and equipment if the required location differs from that indicated on the drawings.

D. Moving Outlets:
   1. The Architect/Owner reserves the right to move any outlet a distance of ten feet before roughing in, at no additional expense to the Owner.

E. Methods and Materials:
   1. All work shall be installed in a first-class, neat and workmanlike manner by skilled mechanics.
   2. All materials shall be new.
   3. Firmly support all materials and equipment.

F. Cutting, Repairing and Finishing:
   1. All cutting, repairing, finishing and painting required for the installation of work under this Contract, in areas of the existing building not being disturbed under the General construction, shall be performed under this Contract.

2. All disturbed surfaces shall be repaired and finished to match adjacent surfaces by skilled mechanics working in their respective fields.
3. Wherever openings are to be made in the existing roof, bonding company approval must be obtained by the Contractor, if roof bond is still in effect, before such openings are made.

G. Excavation, Backfilling and Blasting:
1. Excavation, backfilling and blasting work shall be in accordance with the requirements of Division 01 and as required to complete the work according to details on drawings.

H. Concrete:
1. Concrete work shall be in accordance with the requirements of Division 03 and as required to complete the work according to details on drawings.

I. Cutting and Patching of Macadam and Concrete Areas:
1. Openings in concrete or macadam required for Electrical construction shall be made by taking extreme precautions to prevent excessive damage to existing facilities.
2. Prior to completion, all disturbed areas shall be closed, restored to normal and finished to match surrounding areas.

J. Access:
1. Install all conduit, wire, cable, wiring devices and equipment to preserve access to all equipment installed under this Contract.

K. Layout of Wiring:
1. The layout of wiring as shown on the drawings shall not be considered as absolute; it shall be subject to changes where necessary to overcome obstacles in construction.
2. Where a major deviation from the plans is indicated by practical consideration, shop drawings shall be submitted showing all deviations in detail to clearly indicate the necessity or desirability for the change.

L. Miscellaneous:
1. Furnish and install all necessary steel angles, beams, channels, hanger rods or other supports for equipment and piping furnished under this Contract requiring support or suspension from (building) structure, except support (steel) (aluminum) where otherwise noted on the plans.

M. Continuity of Service:
1. Uninterrupted electrical, telephone and CATV service shall be maintained during the entire time required for complete installation of the work contemplated under these specifications and drawings.
2. Temporary equipment, cable and whatever else is necessary shall be provided as required to maintain electrical, telephone and CATV service. Temporary service facilities, if required at any time, shall not be disconnected or removed until new services are placed in proper operation.
3. If any service or system must be interrupted, the Contractor shall request permission in writing stating the date, time, etc. the same will be interrupted and the areas affected. This request shall be made in sufficient time for proper arrangements to be made. Written permission shall be obtained from the Owner before interrupting electrical, telephone or CATV service.

N. Clean Up:

1. Upon completion of all work under electrical specifications, furnish labor, materials and incidentals to accomplish the following: remove all dirt, foreign materials, stains, fingerprints, etc. from all lighting fixtures, glassware, panelboards, wall plates, system equipment, floors, walls and ceilings adjacent to the above equipment and leave the electrical work in such a condition that no cleaning will be required by the Owner.
2. The complete system shall be subject to inspection and approval by the Architect.

END OF SECTION 260500

DIVISION 26
SECTION 26 05 00.0 GENERAL ELECTRICAL REQUIREMENTS

1.1 Description of Work:

A. The work of this Section consists of providing all required labor, supervision, materials and equipment to satisfactorily complete all electrical installations that are shown on the Civil Drawings and included in these specifications. Electric utilities that are either mounted to the exterior or contained within the proposed structures is specifically excluded from these specifications.

B. Furnish and install all required in-place equipment, conduits, and any miscellaneous materials for the satisfactory interconnection and operation of electrical equipment contained within the Civil Drawings..

1.2 Related Work:

A. This Section provides the basic Electrical Requirements which supplement the General Requirements of Division 01.

1.3 Submittals:

A. As specified in Division 01. Submit to the Owners Representative shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system specified. Information to be submitted includes manufacturer's descriptive literature of cataloged products, equipment, drawings, diagrams, performance and characteristic curves as applicable, test data and catalog cuts. Obtain written approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review. Furnish manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Industry and Technical Society Publication References, and years of satisfactory service of each item required to establish contract compliance. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval.

B. Organize submittals for equipment and items related to each specification section together as a package.

C. Proposed substitutions of products will not be reviewed or approved prior to awarding of the Contract.

D. Substitutions shall be proven to the Owners Representative to be equal or superior to the specified product. The reviewer's decision is final.

E. If a proposed substitution is rejected, the contractor shall furnish the specified product at no increase in contract price.

F. If a proposed substitution is accepted, the contractor shall be completely responsible for all dimensional changes, electrical changes, or changes to other work which are a result of the substitution. The accepted substitution shall be made at no additional cost to the owner or design consultants.

1.4 Quality Assurance:

A. Codes: All electrical equipment and materials, including installation and testing, shall conform to the latest editions following applicable codes:

B. Pennsylvania Electrical Code (CEC).

C. Occupational Safety and Health Act (OSHA) standards.

D. All applicable local codes, rules and regulations.

E. Electrical Contractor shall posses a C-10 license and all other licenses as may be required. Licenses shall be in effect at start of this contract and be maintained throughout the duration of this contract.

F. Variances: In instances where two or more codes are at variance, the most restrictive requirement shall apply.

G. Standards: Equipment shall conform to applicable standards of American National Standards Institute (ANSI), Electronics Industries Association (EIA), Institute of Electrical and Electronics Engineers (IEEE), and National Electrical Manufacturers Association (NEMA).

H. Underwriter Laboratories (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories. Provide service entrance labels for all equipment required by the NEC to have such labels.

I. The electrical contractor shall guarantee all work and materials installed under this contract for a period of one (1) year from date of acceptance by owner.

1.4.1 All work and materials covered by this specification shall be subject to inspection at any and all times by representatives of the owner. Work shall not be closed in or covered before inspection and approval by the owner or his representative. Any material found not conforming with these specifications shall, within 3 days after being notified by the owner, be removed from premises; if said material has been installed, entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be borne by the contractor.

1.5 Contract Documents:

1.5.1 Drawings and Specifications:

1.5.1.1 In the case of conflict between the drawings and specifications, the most restrictive shall take precedence.

1.5.1.2 Drawings and specifications are intended to comply with all law, ordinances, rules and regulations of constituted authorities having jurisdiction, and where referred to in the Contract Documents, said laws, ordinance, rules and regulations shall be considered as a part of said Contract Documents within the limits specified. The Contractor shall bear all expenses of correcting work done contrary to said laws, ordinance, rules and regulations if the Contractor knew or should have known that the work as performed is contrary to said laws, ordinances, rules and regulations and if the Contractor performed same (1) without first consulting the Owners Representative for further instructions regarding said work and/or (2) disregarded the Owners Representative's instructions regarding said work.

1.5.2 Drawings: The Electrical Drawings shall govern the general layout of the completed construction.

1.5.2.1 Locations of equipment, panels, pullboxes, conduits, stub-ups, ground connections are approximate unless dimensioned; verify locations with the Owners Representative prior to installation.

1.5.2.2 Review the Drawings and Specification Divisions of other trades and perform the electrical work that will be required for those installations.

1.5.2.3 Should there be a need to deviate from the Electrical Drawings and Specifications, submit written details and reasons for all changes to the Owners Representative for approval.

1.5.2.4 The general arrangement and location of existing conduits, piping, apparatus, etc., is approximate. The drawings and specifications are for the assistance and guidance of the contractor, exact locations, distances and elevations are governed by actual field conditions. Accuracy of data given herein and on the drawings is not

guaranteed. Minor changes may be necessary to accommodate work. The contractor is responsible for verifying existing conditions. Should it be necessary to deviate from the design due to interference with existing conditions or work in progress, claims for additional compensation shall be limited to those for work required by unforeseen conditions as determined by the Owners Representative.

1.5.2.5 All drawings and divisions of these specifications shall be considered as whole. The contractor shall report any apparent discrepancies to the Owners Representative prior to submitting bids.

1.5.2.6 The contractor shall be held responsible to have examined the site and compared it with the specifications and plans and to have satisfied himself as to the conditions under which the work is to be performed. He shall be held responsible for knowledge of all existing conditions whether or not accurately described. No subsequent allowance shall be made for any extra expense due to failure to make such examination.

1.6 Closeout Submittals:

1.6.1 Manuals: Furnish manuals for equipment where manuals are specified in the equipment specifications or are specified in Division 01.

1.7 Coordination:

1.7.1 Coordinate the electrical work with the other trades, code authorities, utilities and the Owners Representative.

1.7.2 Provide and install all trenching, backfilling, conduit, pull boxes, splice boxes, etc. for all Utility Company services to the locations indicated on the Drawings. All materials and construction shall be in accordance with the requirements for all the Utility Companies. Prior to performing any work, the Electrical Contractor shall coordinate with the various Utility Companies and obtain utility company engineering drawings. Verify that all such work and materials shown on the Drawings are of sufficient sizes and correctly located to provide services on the site. The Electrical Contractor shall verify with all the Utility Companies that additional contractor furnished and installed work is not required. If additional work, materials, or changes are required by any of the Utility Companies, the Electrical Contractor shall advise the Owners Representative of such changes and no further work shall then be performed until instructed to do so by the Owners Representative. The Electrical Contractor shall coordinate with the various Utility Companies to schedule inspections and to obtain service connections.

1.7.3 The Electrical Contractor shall schedule all utility work necessary for utility inspections, connections, cable installation, etc. for the new electrical service to meet the construction schedule.

1.7.4 Utility Company charges shall be paid by the Owner.

1.7.5 Contractor shall pay all inspection and other applicable fees and procure all permits necessary for the completion of this work.

1.7.6 Where connections must be made to existing installations, properly schedule all the required work, including the power shutdown periods.

1.7.7 When two trades join together in an area, make certain that no electrical work is omitted.

1.8 Job Conditions:

1.8.1 Operations: Perform all work in compliance with Division 01 (NIC).

1.8.1.1 Keep the number and duration of power shutdown periods to a minimum.

1.8.1.2 Show all proposed shutdowns and their expected duration on the construction schedule. Schedule and carry out shutdowns so as to cause the least disruption to operation of the Owner's facilities.

1.8.1.3 Carry out shutdown only after the schedule has been approved, in writing, by the owner. Submit power interruption schedule 15 days prior to date of interruption.

1.8.2 Construction Power: Unless otherwise noted in Division 01 of these specifications, contractor shall obtain power during construction from the temporary service provided by the owner at the existing residence. Energy costs shall be paid for by the Owner.

1.8.3 Storage: Provide adequate storage for all equipment and materials which will become part of the completed facility so that it is protected from weather, dust, water, or construction operations.

1.9 Damaged Products:

1.9.1 Notify the Owners Representative in writing in the event that any equipment or material is damaged. Obtain approval from the Owners Representative before making repairs to damaged products.

1.10 Locations:

A. General: Use equipment, materials and wiring methods suitable for the types of locations in which they are located.

B. Dry Locations: All indoor areas, specified by the Architect or MEP Engineer, that do not fall within the definition below for Wet Locations and which are not otherwise designated on the Drawings.

C. Wet Locations: All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Drawings.

1.11 Safety and Indemnity:

A. The Contractor is solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continually and not be limited to normal working hours. The contractor shall provide and maintain throughout the work site proper safeguards including, but not limited to, enclosures, barriers, warning signs, lights, etc. to prevent accidental injury to people or damage to property.

B. No act, service, drawing review or construction review by the Owner, the Engineer or their Consultants is intended to include reviews of the adequacy of the Contractors safety measures in or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify, and defend the Owner, the Engineer, their consultants, and each of their officers, agents and employees from any and all liability claims, losses, or damage arising out of or alleged to arise from bodily injury, sickness, or death of a person or persons and for all damages arising out of injury to or destruction of property arising directly or indirectly out of or in connection with the performance of the work under this Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the construction contract documents, but not including liability that may be due to the sole negligence of the Owner, the Engineer, their Consultants or their officers, agents and employees.

D. If a work area is encountered that contains hazardous materials, the contractor is advised to coordinate with the owner and it's abatement consultant for abatement of hazardous material by the Owner’s Representative. “Hazardous materials” means any toxic substance regulated or controlled by OSHA, EPA, State of California or local rules, regulations and laws. Nothing herein shall be construed to create a liability for Aurum Consulting Engineers regarding hazardous materials abatement measures, or discovery of hazardous materials.

PART 2 - PRODUCTS

2.01 Standard of Quality:

A. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are established to be equal to the specified product and approved by the Owners Representative prior to installation.

B. Material and Equipment: Provide materials and equipment that are new and are current products of manufacturers regularly engaged in the production of such products. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period includes use of equipment and materials of similar size under similar circumstances. For uniformity, only one manufacturer will be accepted for each type of product.

C. Service Support: Submit a certified list of qualified permanent service organizations including their addresses and qualification for support of the equipment. These service organizations shall be convenient to the equipment installation and able to render service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Manufacturer's Recommendations: Where installation procedures are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendation shall be cause for rejection of the equipment or material.

2.02 Materials:

A. Schedule 80 PVC Conduit and all fittings (varying sizes)
B. Pre-cast concrete transformer pad
C. Pre-cast transformer vault as approved by First Energy Corp (Met Ed) – Code J2 Transformer Foundation Dimensions
D. Grounding Rods
E. Fasteners for securing equipment shall be either hot-dip galvanized after fabrication or stainless steel.

PART 3 - EXECUTION

3.01 Workmanship:

A. Ensure that all equipment and materials fit properly in their installation.

B. Perform any required work to correct improperly fit installation at no additional expense to the owner.

C. All electrical equipment and materials shall be installed in a neat and workmanship

manner in accordance with the "NECA-1 Standard Practices for Good Workmanship in Electrical Contracting". Workmanship of the entire job shall be first class in every respect.

3.02 Equipment Installations:

A. Provide the required inserts, bolts and anchors, and securely attach all equipment and materials to their supports.

B. Do all the cutting and patching necessary for the proper installation of work and repair any damage done.

3.03 Field Test:

A. Test shall be in accordance with Acceptance testing specifications issued by the National Electrical Testing Association (NETA).

B. Perform equipment field tests and adjustments. Properly calibrate, adjust and operationally check all circuits and components, and demonstrate as ready for service. Make additional calibration and adjustments if it is determined later that the initial adjustments are not satisfactory for proper performance. Perform equipment field test for equipment where equipment field tests are specified in the equipment Specifications. Give sufficient notice to the Owners Representative prior to any test so that the tests may be witnessed.

C. Provide instruments, other equipment and material required for the tests. These shall be of the type designed for the type of tests to be performed. Test instrument shall be calibrated by a recognized testing laboratory within three months prior to performing tests.

D. Operational Tests: Operationally test all circuits to demonstrate that the circuits and equipment have been properly installed and adjusted and are ready for full-time service. Demonstrate the proper functioning of circuits in all modes of operation, including alarm conditions.

E. Re-testing will be required for all unsatisfactory tests after the equipment or system has been repaired. Re-test all related equipment and systems if required by the Owners Representative. Repair and re-test equipment and systems which have been satisfactorily tested but later fail, until satisfactory performance is obtained.

F. Maintain records of each test and submit five copies to the Owners Representative when testing is complete. All tests shall be witnessed by the Owners Representative. These records shall include:

1. Name of equipment tested.

2. Date of report.

3. Date of test.

4. Description of test setup.

5. Identification and rating of test equipment.

6. Test results and data.

7. Name of person performing test.

8. Owner or Owners Representative's initials.

G. Items requiring testing shall be as noted in the additional electrical sections of these specifications.

3.04 Cleaning Equipment:

A. Thoroughly clean all soiled surfaces of installed equipment and materials.

3.05 Records:

A. Maintain one copy of the contract Drawing Sheets on the site of the work for recording the "as built" condition. After completion of the work, the Contractor shall carefully mark the work as actually constructed, revising, deleting and adding to the Drawing Sheets as required. The following requirements shall be complied with:

1. Cable Size and Type: Provide the size and type of each cable installed on project.

2. Substructure: Where the location of all underground conduits, pull boxes, stub ups and etc. where are found to be different than shown, carefully mark the correct location on the Drawings. Work shall be dimensioned from existing improvements.

3. Size of all conduit runs.

4. Routes of conduit runs below grade.

5. Changes made as a result of all approved change orders, addendums, or field authorized revisions.

6. As Builts: At the completion of the Work the Contractor shall review, certify, correct and turn over the marked up Drawings to the Owners Representative for his use in preparing "as built" plans.

7. As built Drawings shall be delivered to the Owners Representative within ten (10) days of completion of construction.

Clean Up:

B. Upon completion of electrical work, remove all surplus materials, rubbish, and debris that accumulated during the construction work. Leave the entire area neat, clean, and acceptable to the Owners Representative.

3.06 Mechanical and Plumbing Electrical Work:

A. The requirements for electrical power and/or devices for all mechanical and plumbing equipment supplied and/or installed under this Contract shall be coordinated and verified with the following:

1. Mechanical and Plumbing Drawings.
2. Mechanical and Plumbing sections of these Specifications.
3. Manufacturers of the Mechanical and Plumbing equipment supplied.

B. The Electrical Contractor shall furnish and install the following for all mechanical and plumbing equipment:

1. Line voltage conduit and wiring.
2. Valve starters for propane tanks.

DIVISION 26
SECTION 26 05 00.0 GENERAL ELECTRICAL REQUIREMENTS

1.1 Description of Work:

A. The work of this Section consists of providing all required labor, supervision, materials and equipment to satisfactorily complete all electrical installations that are shown on the Civil Drawings and included in these specifications. Electric utilities that are either mounted to the exterior or contained within the proposed structures is specifically excluded from these specifications.

B. Furnish and install all required in-place equipment, conduits, and any miscellaneous materials for the satisfactory interconnection and operation of electrical equipment contained within the Civil Drawings..

1.2 Related Work:

A. This Section provides the basic Electrical Requirements which supplement the General Requirements of Division 01.

1.3 Submittals:

A. As specified in Division 01. Submit to the Owners Representative shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system specified. Information to be submitted includes manufacturer's descriptive literature of cataloged products, equipment, drawings, diagrams, performance and characteristic curves as applicable, test data and catalog cuts. Obtain written approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review. Furnish manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Industry and Technical Society Publication References, and years of satisfactory service of each item required to establish contract compliance. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval.

B. Organize submittals for equipment and items related to each specification section together as a package.

C. Proposed substitutions of products will not be reviewed or approved prior to awarding of the Contract.

D. Substitutions shall be proven to the Owners Representative to be equal or superior to the specified product. The reviewer's decision is final.

E. If a proposed substitution is rejected, the contractor shall furnish the specified product at no increase in contract price.

F. If a proposed substitution is accepted, the contractor shall be completely responsible for all dimensional changes, electrical changes, or changes to other work which are a result of the substitution. The accepted substitution shall be made at no additional cost to the owner or design consultants.

1.4 Quality Assurance:

A. Codes: All electrical equipment and materials, including installation and testing, shall conform to the latest editions following applicable codes:

B. Pennsylvania Electrical Code (CEC).

C. Occupational Safety and Health Act (OSHA) standards.

D. All applicable local codes, rules and regulations.

E. Electrical Contractor shall posses a C-10 license and all other licenses as may be required. Licenses shall be in effect at start of this contract and be maintained throughout the duration of this contract.

F. Variances: In instances where two or more codes are at variance, the most restrictive requirement shall apply.

G. Standards: Equipment shall conform to applicable standards of American National Standards Institute (ANSI), Electronics Industries Association (EIA), Institute of Electrical and Electronics Engineers (IEEE), and National Electrical Manufacturers Association (NEMA).

H. Underwriter Laboratories (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories. Provide service entrance labels for all equipment required by the NEC to have such labels.

I. The electrical contractor shall guarantee all work and materials installed under this contract for a period of one (1) year from date of acceptance by owner.

1.4.1 All work and materials covered by this specification shall be subject to inspection at any and all times by representatives of the owner. Work shall not be closed in or covered before inspection and approval by the owner or his representative. Any material found not conforming with these specifications shall, within 3 days after being notified by the owner, be removed from premises; if said material has been installed, entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be borne by the contractor.

1.5 Contract Documents:

1.5.1 Drawings and Specifications:

1.5.1.1 In the case of conflict between the drawings and specifications, the most restrictive shall take precedence.

1.5.1.2 Drawings and specifications are intended to comply with all law, ordinances, rules and regulations of constituted authorities having jurisdiction, and where referred to in the Contract Documents, said laws, ordinance, rules and regulations shall be considered as a part of said Contract Documents within the limits specified. The Contractor shall bear all expenses of correcting work done contrary to said laws, ordinance, rules and regulations if the Contractor knew or should have known that the work as performed is contrary to said laws, ordinances, rules and regulations and if the Contractor performed same (1) without first consulting the Owners Representative for further instructions regarding said work and/or (2) disregarded the Owners Representative's instructions regarding said work.

1.5.2 Drawings: The Electrical Drawings shall govern the general layout of the completed construction.

1.5.2.1 Locations of equipment, panels, pullboxes, conduits, stub-ups, ground connections are approximate unless dimensioned; verify locations with the Owners Representative prior to installation.

1.5.2.2 Review the Drawings and Specification Divisions of other trades and perform the electrical work that will be required for those installations.

1.5.2.3 Should there be a need to deviate from the Electrical Drawings and Specifications, submit written details and reasons for all changes to the Owners Representative for approval.

1.5.2.4 The general arrangement and location of existing conduits, piping, apparatus, etc., is approximate. The drawings and specifications are for the assistance and guidance of the contractor, exact locations, distances and elevations are governed by actual field conditions. Accuracy of data given herein and on the drawings is not

guaranteed. Minor changes may be necessary to accommodate work. The contractor is responsible for verifying existing conditions. Should it be necessary to deviate from the design due to interference with existing conditions or work in progress, claims for additional compensation shall be limited to those for work required by unforeseen conditions as determined by the Owners Representative.

1.5.2.5 All drawings and divisions of these specifications shall be considered as whole. The contractor shall report any apparent discrepancies to the Owners Representative prior to submitting bids.

1.5.2.6 The contractor shall be held responsible to have examined the site and compared it with the specifications and plans and to have satisfied himself as to the conditions under which the work is to be performed. He shall be held responsible for knowledge of all existing conditions whether or not accurately described. No subsequent allowance shall be made for any extra expense due to failure to make such examination.

1.6 Closeout Submittals:

1.6.1 Manuals: Furnish manuals for equipment where manuals are specified in the equipment specifications or are specified in Division 01.

1.7 Coordination:

1.7.1 Coordinate the electrical work with the other trades, code authorities, utilities and the Owners Representative.

1.7.2 Provide and install all trenching, backfilling, conduit, pull boxes, splice boxes, etc. for all Utility Company services to the locations indicated on the Drawings. All materials and construction shall be in accordance with the requirements for all the Utility Companies. Prior to performing any work, the Electrical Contractor shall coordinate with the various Utility Companies and obtain utility company engineering drawings. Verify that all such work and materials shown on the Drawings are of sufficient sizes and correctly located to provide services on the site. The Electrical Contractor shall verify with all the Utility Companies that additional contractor furnished and installed work is not required. If additional work, materials, or changes are required by any of the Utility Companies, the Electrical Contractor shall advise the Owners Representative of such changes and no further work shall then be performed until instructed to do so by the Owners Representative. The Electrical Contractor shall coordinate with the various Utility Companies to schedule inspections and to obtain service connections.

1.7.3 The Electrical Contractor shall schedule all utility work necessary for utility inspections, connections, cable installation, etc. for the new electrical service to meet the construction schedule.

1.7.4 Utility Company charges shall be paid by the Owner.

1.7.5 Contractor shall pay all inspection and other applicable fees and procure all permits necessary for the completion of this work.

1.7.6 Where connections must be made to existing installations, properly schedule all the required work, including the power shutdown periods.

1.7.7 When two trades join together in an area, make certain that no electrical work is omitted.

1.8 Job Conditions:

1.8.1 Operations: Perform all work in compliance with Division 01 (NIC).

1.8.1.1 Keep the number and duration of power shutdown periods to a minimum.

1.8.1.2 Show all proposed shutdowns and their expected duration on the construction schedule. Schedule and carry out shutdowns so as to cause the least disruption to operation of the Owner's facilities.

1.8.1.3 Carry out shutdown only after the schedule has been approved, in writing, by the owner. Submit power interruption schedule 15 days prior to date of interruption.

1.8.2 Construction Power: Unless otherwise noted in Division 01 of these specifications, contractor shall obtain power during construction from the temporary service provided by the owner at the existing residence. Energy costs shall be paid for by the Owner.

1.8.3 Storage: Provide adequate storage for all equipment and materials which will become part of the completed facility so that it is protected from weather, dust, water, or construction operations.

1.9 Damaged Products:

1.9.1 Notify the Owners Representative in writing in the event that any equipment or material is damaged. Obtain approval from the Owners Representative before making repairs to damaged products.

1.10 Locations:

A. General: Use equipment, materials and wiring methods suitable for the types of locations in which they are located.

B. Dry Locations: All indoor areas, specified by the Architect or MEP Engineer, that do not fall within the definition below for Wet Locations and which are not otherwise designated on the Drawings.

C. Wet Locations: All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Drawings.

1.11 Safety and Indemnity:

A. The Contractor is solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continually and not be limited to normal working hours. The contractor shall provide and maintain throughout the work site proper safeguards including, but not limited to, enclosures, barriers, warning signs, lights, etc. to prevent accidental injury to people or damage to property.

B. No act, service, drawing review or construction review by the Owner, the Engineer or their Consultants is intended to include reviews of the adequacy of the Contractors safety measures in or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify, and defend the Owner, the Engineer, their consultants, and each of their officers, agents and employees from any and all liability claims, losses, or damage arising out of or alleged to arise from bodily injury, sickness, or death of a person or persons and for all damages arising out of injury to or destruction of property arising directly or indirectly out of or in connection with the performance of the work under this Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the construction contract documents, but not including liability that may be due to the sole negligence of the Owner, the Engineer, their Consultants or their officers, agents and employees.

D. If a work area is encountered that contains hazardous materials, the contractor is advised to coordinate with the owner and it's abatement consultant for abatement of hazardous material by the Owner’s Representative. “Hazardous materials” means any toxic substance regulated or controlled by OSHA, EPA, State of California or local rules, regulations and laws. Nothing herein shall be construed to create a liability for Aurum Consulting Engineers regarding hazardous materials abatement measures, or discovery of hazardous materials.

PART 2 - PRODUCTS

2.01 Standard of Quality:

A. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are established to be equal to the specified product and approved by the Owners Representative prior to installation.

B. Material and Equipment: Provide materials and equipment that are new and are current products of manufacturers regularly engaged in the production of such products. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period includes use of equipment and materials of similar size under similar circumstances. For uniformity, only one manufacturer will be accepted for each type of product.

C. Service Support: Submit a certified list of qualified permanent service organizations including their addresses and qualification for support of the equipment. These service organizations shall be convenient to the equipment installation and able to render service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Manufacturer's Recommendations: Where installation procedures are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendation shall be cause for rejection of the equipment or material.

2.02 Materials:

A. Schedule 80 PVC Conduit and all fittings (varying sizes)
B. Pre-cast concrete transformer pad
C. Pre-cast transformer vault as approved by First Energy Corp (Met Ed) – Code J2 Transformer Foundation Dimensions
D. Grounding Rods
E. Fasteners for securing equipment shall be either hot-dip galvanized after fabrication or stainless steel.

PART 3 - EXECUTION

3.01 Workmanship:

A. Ensure that all equipment and materials fit properly in their installation.

B. Perform any required work to correct improperly fit installation at no additional expense to the owner.

C. All electrical equipment and materials shall be installed in a neat and workmanship

manner in accordance with the "NECA-1 Standard Practices for Good Workmanship in Electrical Contracting". Workmanship of the entire job shall be first class in every respect.

3.02 Equipment Installations:

A. Provide the required inserts, bolts and anchors, and securely attach all equipment and materials to their supports.

B. Do all the cutting and patching necessary for the proper installation of work and repair any damage done.

3.03 Field Test:

A. Test shall be in accordance with Acceptance testing specifications issued by the National Electrical Testing Association (NETA).

B. Perform equipment field tests and adjustments. Properly calibrate, adjust and operationally check all circuits and components, and demonstrate as ready for service. Make additional calibration and adjustments if it is determined later that the initial adjustments are not satisfactory for proper performance. Perform equipment field test for equipment where equipment field tests are specified in the equipment Specifications. Give sufficient notice to the Owners Representative prior to any test so that the tests may be witnessed.

C. Provide instruments, other equipment and material required for the tests. These shall be of the type designed for the type of tests to be performed. Test instrument shall be calibrated by a recognized testing laboratory within three months prior to performing tests.

D. Operational Tests: Operationally test all circuits to demonstrate that the circuits and equipment have been properly installed and adjusted and are ready for full-time service. Demonstrate the proper functioning of circuits in all modes of operation, including alarm conditions.

E. Re-testing will be required for all unsatisfactory tests after the equipment or system has been repaired. Re-test all related equipment and systems if required by the Owners Representative. Repair and re-test equipment and systems which have been satisfactorily tested but later fail, until satisfactory performance is obtained.

F. Maintain records of each test and submit five copies to the Owners Representative when testing is complete. All tests shall be witnessed by the Owners Representative. These records shall include:

1. Name of equipment tested.

2. Date of report.

3. Date of test.

4. Description of test setup.

5. Identification and rating of test equipment.

6. Test results and data.

7. Name of person performing test.

8. Owner or Owners Representative's initials.

G. Items requiring testing shall be as noted in the additional electrical sections of these specifications.

3.04 Cleaning Equipment:

A. Thoroughly clean all soiled surfaces of installed equipment and materials.

3.05 Records:

A. Maintain one copy of the contract Drawing Sheets on the site of the work for recording the "as built" condition. After completion of the work, the Contractor shall carefully mark the work as actually constructed, revising, deleting and adding to the Drawing Sheets as required. The following requirements shall be complied with:

1. Cable Size and Type: Provide the size and type of each cable installed on project.

2. Substructure: Where the location of all underground conduits, pull boxes, stub ups and etc. where are found to be different than shown, carefully mark the correct location on the Drawings. Work shall be dimensioned from existing improvements.

3. Size of all conduit runs.

4. Routes of conduit runs below grade.

5. Changes made as a result of all approved change orders, addendums, or field authorized revisions.

6. As Builts: At the completion of the Work the Contractor shall review, certify, correct and turn over the marked up Drawings to the Owners Representative for his use in preparing "as built" plans.

7. As built Drawings shall be delivered to the Owners Representative within ten (10) days of completion of construction.

Clean Up:

B. Upon completion of electrical work, remove all surplus materials, rubbish, and debris that accumulated during the construction work. Leave the entire area neat, clean, and acceptable to the Owners Representative.

3.06 Mechanical and Plumbing Electrical Work:

A. The requirements for electrical power and/or devices for all mechanical and plumbing equipment supplied and/or installed under this Contract shall be coordinated and verified with the following:

1. Mechanical and Plumbing Drawings.
2. Mechanical and Plumbing sections of these Specifications.
3. Manufacturers of the Mechanical and Plumbing equipment supplied.

B. The Electrical Contractor shall furnish and install the following for all mechanical and plumbing equipment:

1. Line voltage conduit and wiring.
2. Valve starters for propane tanks.

# SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

### 1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of times the applied force.

### 1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.

### 1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. Fabco Plastics Wholesale Limited.
      d. Seasafe, Inc.
   2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   3. Fitting and Accessory Materials: Same as channels and angles[, except metal items may be stainless steel].
   4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [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.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   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.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

# 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. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. 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].

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [IMC] [RMC] [EMT, IMC, and RMC] may be supported by openings through structure members, as permitted in NFPA 70.

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

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To 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.
   6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

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

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

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section – 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.

## 3.5 PAINTING

A. Touchup: Comply with requirements in Division 09 - Finishes for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:
a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.

c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

## 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

# PART 2 – PRODUCTS

## 2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. O-Z Gedney; a unit of General Signal.
6. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated [rigid steel conduit] [IMC].
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch minimum.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: Steel type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. CertainTeed Corp.; Pipe & Plastics Group.
   4. Lamson & Sessions; Carlon Electrical Products.
   5. RACO; a Hubbell Company.
   6. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, [Type EPC-40-PVC, ]unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.\

## 2.3 METAL WIREWAYS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type [1] [12] [3R], unless otherwise indicated.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

C. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

D. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

E. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. [Manufacturer's standard enamel finish in color selected by Architect
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Wiring Device; Kellems Division
   b. Walker Systems, Inc.; Wiremold Company (The).
   c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from [manufacturer's standard] [custom] colors.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Incorporated; Wiring Device-Kellems Division.
   b. Panduit Corp.
   c. Walker Systems, Inc.; Wiremold Company (The).
   d. Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. O-Z/Gedney; a unit of General Signal.
   7. RACO; a Hubbell Company.
   8. Robroy Industries, Inc.; Enclosure Division.
   9. Scott Fetzer Co.; Adalet Division.
   10. Spring City Electrical Manufacturing Company.
   11. Thomas & Betts Corporation.
   12. Walker Systems, Inc.; Wiremold Company (The).
   13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] [aluminum], Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

## 2.7 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

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

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

A. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT
   2. Exposed, Not Subject to Severe Physical Damage: EMT
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Damp or Wet Locations: Rigid steel conduit.
   5. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

B. Minimum Raceway Size: 3/4-inch (21-mm)] trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
   3. EMT steel conduit: Use set-screw type conduit fittings.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits in contact with concrete.

### 3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

I. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

J. 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.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. 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.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.
   3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. 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.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

## 3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
    1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
    2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

## 3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

## 3.7 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

# SECTION 262416 - PANELBOARDS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Load centers.

### 1.3 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Qualification Data: For qualified testing agency.

C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

### 1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; store panels in heated space to prevent condensation.

## 1.6 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.
3. Comply with NFPA 70E.

## 1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Surface mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   6. Finishes:
      a. Panels and Trim: Steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: [Same finish as panels and trim.
      c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
   7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Phase, Neutral, and Ground Buses:
   1. Material: Tin-plated aluminum.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
   5. Split Bus: Vertical buses divided into individual vertical sections.

D. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

D. Mains: Circuit breaker.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

## 2.4 LOAD CENTERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

B. Load Centers: Comply with UL 67.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

## 3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

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 panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim [a maximum of 90 inches (2286 mm)] <Insert height> above finished floor unless otherwise indicated.

F. 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.

G. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from recessed mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties[ after completing load balancing].

K. Comply with NECA 1.

## 3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads[ after balancing panelboard loads]; incorporate Owner's final room designations. Obtain approval before installing. 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 Division 26 Section "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 Division 26 Section "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Tests and Inspections:
   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. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [as indicated] [as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."]

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

## 3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.

B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.
   2. Division 27 Section “Lighting Control Devices” for wall box occupancy sensors.

1.2 REFERENCES

A. NECA – Standard of Installation.

B. NEMA WD 1 – General Requirements for Wiring Devices.

C. NEMA WD 6 – Wiring Device – Dimensional Requirements.

D. NFPA 70 – National Electrical Code, Latest Edition.

1.3 SUBMITTALS

A. Submit in Accordance with provisions of Division 01 – General Requirements.

B. Product Data: For each type of product indicated. Provide manufacturer’s catalog information showing dimensions, colors and configurations.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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 NFPA 70 – National Electrical Code, Latest Edition.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers':
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Leviton Mfg. Company Inc.
   3. Pass & Seymour/Legrand; Wiring Devices & Accessories.
   4. Bryant
   5. A & H
   6. Eagle

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; SR20 (single), 5352 (duplex).
      b. Leviton; 5891 (single), 5352 (duplex).
      c. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; IG 5362 or IG20.
      b. Leviton; 5362-IG.
      c. Pass & Seymour; IG6300.
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL8300SG.
      b. Leviton; 8300-SGG.
      c. Pass & Seymour; 63H.
   2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, [feed] [non-feed]-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell #GF20L.
      b. Pass & Seymour; 2095.

2.4 SPECIAL RECEPTACLES

A. Range receptacle, 125/250V, 50A: UL listed E1706, CSA Certified, 75 degree C rated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; RR450F

B. Dryer receptacle, 125/250V, 30A: UL listed E1706, CSA certified, 75 degree C rated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; RR430F

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, high-impact thermoplastic
   3. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, Standard of installation.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. 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 the 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. Clean all debris from outlet boxes.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.
5. Provide extension rings to bring outlet boxes flush with finished surfaces.

C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles [up] [down], and on horizontally mounted receptacles to the [right] [left].
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade [convenience outlets in patient-care areas] [hospital-grade convenience outlets] for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION 262726

# SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Non fusible switches.
   3. Shunt trip switches.
   4. Molded-case circuit breakers (MCCBs).

### 1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### 1.4 SUBMITTALS

A. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

B. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.[ Submit on translucent log-log graph paper.]

### 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, 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 NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
   1.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with [cartridge] [plug] fuse interiors to accommodate [specified] [indicated] fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate [specified] [indicated] fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, [240] [600]-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate [specified] [indicated] fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate [specified] [indicated]

fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

## 2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, [240] [600]-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

## 2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac;

## 2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

### 3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

## 3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

## 3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Tests and Inspections:
   1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

## 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

# SECTION 263213 - ENGINE GENERATORS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
   1. Diesel engine.
   2. Unit-mounted cooling system.
   3. Unit-mounted control and monitoring.
   4. Performance requirements for sensitive loads.
   5. Outdoor enclosure.
   6. Subbase fuel tank with remote alarm panel.

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and stopping signals for engine-generator sets.

### 1.3 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.
   2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
   2. Generator.
   3. Day Tank with 110% Containment Tank.
   4. Subbase Fuel Tank with Fuel Leak Detection.
   5. Fuel Transfer Pump.
   6. Oil Base Heater (15kW and below).
   7. Combustion Chamber Preheater.
   8. Coolant Jacket Heater.
   9. Battery Pad Heater.
   10. Area Protection Panel.
   11. Muffler.
   12. Emergency Stop.

13. Solenoid Valve.
14. Remote Generator Alarm Annunciator Panel.
15. Fuel Leak Alarm Panel.

C. Manufacturer Seismic Qualification Certification: Submit certification that [day tank] engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
   4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   5. Report of sound generation.
   6. Report of exhaust emissions showing compliance with applicable regulations.
   7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, and source of supply.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
   2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles] of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. 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.

E. Comply with ASME B15.1.

F. Comply with NFPA 37 – Standard for the installation and use of stationary combustion engines and gas turbines.

G. Comply with NFPA 70 – National Electrical Code.

H. Comply with NFPA 99 – Standard for Health Care Facilities.

I. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

J. Comply with UL 2200.

K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

## 1.5 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: Minus 15 to plus 40 deg C.
   2. Relative Humidity: 0 to 95 percent.
   3. Altitude: Sea level to 1000 feet.

## 1.6 COORDINATION

A. Coordinate size and location of concrete base for package engine generators on. Cast anchor-bolt inserts into bases.

## 1.7 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, after 6 months of operation contractor shall provide a full maintenance check-up by skilled employees of manufacturer's

designated service organization. Check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Kohler Co.; Generator Division.
   2. Generac Power Systems, Inc.
   3. Onan/Cummins Power Generation; Industrial Business Group.
   4. Spectrum Detroit Diesel.
   5. Caterpillar; Engine Div.

### 2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.
   1. Emergency generator shall be as follows:
      a. Manufacturer:
      b. Catalog Number:
      c. kW Rating:
      d. Voltage:
      e. Phase:
      f. Number of Wires:
      g. Fueled by:
      h. Cooled by: Air, Liquid (Select One)

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated[, with capacity as required to operate as a unit as evidenced by records of prototype testing].
   2. Output Connections: Three-phase, [three] [four] wire.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
   a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Grade DF-2

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
   1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
   2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
   4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
   5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
      a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Muffler/Silencer: Residential type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 18 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 95 dBA or less.

H. Air-Intake Filter: Standard duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: [As required by NFPA 110 for system level specified] [60 seconds].
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least [twice] [three times] without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

## 2.4 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
   1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
   2. Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards."
   3. Switchgear Construction: Freestanding unit complying with Division 26 Section "Low-Voltage Switchgear."
   4. Current and Potential Transformers: Instrument accuracy class.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level [1] [2] system, and the following:
   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.
   6. Engine lubricating-oil pressure gage.
   7. Running-time meter.
   8. Ammeter-voltmeter, phase-selector switch(es).
   9. Generator-voltage adjusting rheostat.
   10. Start-stop switch.
   11. Overspeed shutdown device.
   12. Coolant high-temperature shutdown device.
   13. Coolant low-level shutdown device.
   14. Oil low-pressure shutdown device.
   15. Fuel tank derangement alarm.
   16. Fuel tank high-level shutdown of fuel supply alarm.
   17. Generator overload.
   18. Battery charger warning.
   19. Lamp test.
   20. Audible alarm silence.

21. Overcrank shutdown.
22. High battery voltage warning.
23. Low battery voltage warning.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

## 2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

## 2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Prefabricated or preengineered walk-in enclosure with the following features:
   1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
   2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
   3. Space Heater: Thermostatically controlled and sized to prevent condensation.
   4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
   5. Hinged Doors: With padlocking provisions.

6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8. Muffler Location: [Within] [External to] enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

## 2.8 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

## 3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

B. Provide a sign at the service entrance equipment indicating type and location of on site emergency power sources.

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. Report results in writing.

B. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
      c. Verify acceptance of charge for each element of the battery after discharge.
      d. Verify that measurements are within manufacturer's specifications.
   4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
   5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
   7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
   8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
   9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at [four] <Insert number> locations [on the property line] <Insert location for measurement>, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations.

K. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.
   2. Remote annunciator panel

1.3 SUBMITTALS

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

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70 – National Electrical Code.

F. Comply with NFPA 99 – Standard for Health Care Facilities.

G. Comply with NFPA 110 – Standard for Emergency and Stand Power Systems.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Contactor Transfer Switches:
      a. Emerson; ASCO Power Technologies, LP
      b. Caterpillar; Engine Div.
      c. Generac Power Systems, Inc.
      d. GE Zenith Controls.
      e. Kohler Power Systems; Generator Division.
      f. Onan/Cummins Power Generation; Industrial Business Group.
      g. Russelectric, Inc.
      h. Spectrum Detroit Diesel.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

I. Battery Charger: For generator starting batteries.
   1. Float type rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

H. Automatic Transfer-Switch Features:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
   7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
      a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
      b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
   8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
   9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
   10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
   11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
   12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
   13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable

from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is not available.

## 2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
   1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
   2. Switch position.
   3. Switch in test mode.
   4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
   1. Indicating Lights: Grouped for each transfer switch monitored.
   2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
   3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
   4. Lamp Test: Push-to-test or lamp-test switch on front panel.

## 2.5 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

## 3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
      a. Check for electrical continuity of circuits and for short circuits.
      b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      c. Verify that manual transfer warnings are properly placed.
      d. Perform manual transfer operation.
   5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      b. Simulate loss of phase-to-ground voltage for each phase of normal source.
      c. Verify time-delay settings.
      d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays.

E. Remove and replace malfunctioning units and retest as specified above.

F. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

G. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 265100 – LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit lights.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Energy-efficiency data.
      a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
      b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Lighting fixtures.
   2. Suspended ceiling components.
   3. Structural members to which suspension systems for lighting fixtures will be attached.
   4. Other items in finished ceiling including the following:
      a. Air outlets and inlets.
      b. Speakers.
      c. Sprinklers.
      d. Smoke and fire detectors.
      e. Occupancy sensors.
      f. Access panels.

C. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. See. “Light Fixture Schedule” on Drawings for complete listing of fixture manufacturers.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Acrylic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
      b. UV stabilized.

2.3 EXIT LIGHT

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Fixture:
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   2. Self-Powered Exit Fixture (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      f. Remote Test: Switch in hand-held 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.
      g. 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 flashing red LED.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element. All lighting fixtures shall be supported with formed channels, angels, rods, wires, clamps, washers, etc. of sufficient size and strength to support the weight of the fixture from the building structure.
   1. Install a minimum of four ceiling support system wires for each fixture. Locate not more than 6 inches from lighting fixture corners. Connect to building structure and independent of ceiling grad.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support wire from structure to a tab on lighting fixture. Wire shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aimable lighting fixtures to provide required light intensities.

## 3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

DIVISION 31 – EARTHWORK
SECTION 31 20 00 – ROUGH GRADING, EXCAVATION, AND TRENCHING

1.1 SCOPE OF WORK

The Contractor is responsible to provide all equipment, tools, labor, and materials necessary to perform earth moving operations as they affect site work, and as outlined below:

A. Excavation
B. Earth moving
C. Embankment
D. Grading
E. Filling and Backfilling
F. Compaction
G. Trenching
H. Finish Grading

2.1 RELATED SECTIONS

A. Soil Erosion and Sediment Control
B. Seeding

3.1 SUBMITTALS

A. Sample shall be supplied from off-site locations of all backfill and fill materials.

4.1 PROTECTION

A. Protect all existing features to remain. The Contractor will be responsible to repair or replace damage to existing items to remain.

5.1 PREPARATION

A. Identify required lines, levels, contours, and datum. Stake and flag existing underground and above ground utilities.
B. Throughout the project area and the limits of disturbance, grading shall be kept to a minimum depending on site conditions.
C. Notify Owner and respective utility companies of intent to remove, relocate or shut off utilities when working within the area, including during excavation.
D. The Contractor will employ a surveyor registered in the Commonwealth of PA to lay out the work and establish all lines and grades. Final approval must be supplied by the Township Representative before any grading/excavation occurs.
E. The grading limit lines, elevations, etc., on drawings shall be followed within close conformity.
F. Prior to grading operations, topsoil encountered shall be stockpiled at an approved location and screened prior to use as topsoil. After all construction has been completed in any given area, screened topsoil from stockpiles shall be spread to finish grade, and the depths of topsoil shall not be less than the depth identified in the fine grading and seeding specification.
G. The Contractor shall be responsible to establish elevation, grades, slopes, and basin dimensions based upon the existing layout and the slope parameters. Final approval of finish

elevation and grades must be supplied by the Owner and their Representative before any grading/excavation occurs.

## 6.1 SUBSURFACE CONDITIONS

A. It is the responsibility of the Contractor to verify the existing site and subsurface conditions prior to proceeding and while progressing with the work.
B. Classification of Excavation: If rock as herein defined, is encountered within the limits of excavation, the contract price will be adjusted upon an agreed unit price per cubic yard. Rock excavation will consist of the removal and disposal of boulders one cubic yard or more in volume; solid rock; materials that cannot be removed without systematic drilling and blasting such as rock material in ledges or aggregate conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock; and concrete or masonry structures exceeding one cubic yard in volume, except sidewalks and paving.
C. Hard and compact materials such as cemented-gravel, glacial till, and relatively soft or disintegrated rock that can be removed without continuous and systematic drilling and blasting will not be considered as rock excavation. Rock excavation will not be considered such because of intermittent drilling and blasting that is performed merely to increase production. Excavation of the material claimed as rock will not be performed until the material has been cross-sectioned and classified by the Owner's Representative.

## 7.1 TESTS

A. If requested, testing and analysis of soils will be performed by an independent testing organization. The Owner shall bear the cost of all testing. As a minimum, the following type and number of tests will be performed.
B. Tests for each proposed fill and backfill material
    1. Gradation per ANSI/ASTM C136 or D422.
    2. Liquid limit, plastic limit and plasticity per ANSI/ASTM D4318.
    3. Moisture-density relationship and maximum dry density per ASTM D698 (Standard Proctor).
    4. Unified soil classification.
C. Tests for soils in-place:
    1. Moisture content per ANSI/ASTM D2216 or D3017.
    2. Density per ANSI/ASTM D1556, D2167, or D2922.
D. Tests for topsoil supplied:
    1. Pesticides, Fertilizers and Heavy Metals
E. Moisture content and field density tests will be taken in each lift of fill or backfill, or pavement subgrade, as follows:
    1. Paved Areas: one test per 5,000 SF.
    2. Backfill for utility trenches: one test per 200 LF.
F. Test results will be sent to the Township Representative immediately following completion of tests. All reports will include the date of test, name of Contractor and all applicable test results.
G. If, in the opinion of the Owner or their representative, additional tests are required to verify compliance with these specifications, the testing service will take additional tests as directed by the Engineer. Costs of additional tests will be the responsibility of the Contractor only if results indicate defective work.

8.1 SOIL MATERIALS

A. Subsoil: Excavated or borrow material, free of lumps larger than six inches, rocks larger than two inches, and debris. Debris shall consist of any material that is not naturally occurring and is incapable of being compacted to the requirements of this section.
B. Topsoil: If needed, topsoil shall consist of friable loam, reasonably free of subsoil, clay lumps, brush, roots, weeds, or other objectionable material unsuitable or harmful to plant growth.

9.1 FILL MATERIALS

A. Granular Fill: Suitable material excavated from off-site may be utilized for filling, backfilling, and grading. Suitable materials will be a well-graded granular material and have the following properties:
    1. Free from organic matter.
    2. Plasticity index will be less than 10, when tested in accordance with ASTM D4318.
    3. Contain less than 15% by weight, particles larger than two (2) inches.
    4. Contain less than 30% by weight, particles passing the No. 200 sieve.
B. Borrow: Off-site borrow material for granular fill will be a clean granular soil, free of clay, friable material, micaceous material, organic material, and debris, conforming to AASHTO classification A-1, A-2-4 or A-3.
C. Crushed Stone: Compacted granular fill beneath asphalt paving, will conform to PennDOT publication 408, 2A modified stone.
D. Select Backfill: Select granular backfill material for backfill to trenches in paved areas, appurtenances, and footings, will conform to PennDOT Section 703, Type 2RC, unless otherwise noted.
E. Pipe Bedding: AASHTO #57 course aggregate.
F. Fill material shall be according to the clean fill definition as shown on erosion and sedimentation notes.

10.1 CLEARING

A. Ensure that all erosion and sediment control devices and tree protection are installed and functioning if required, as per the drawings.
B. Remove debris, rock and extracted plant life from site within limits of grading. Debris and rocks shall be disposed of at a facility accepting such material.

11.1 ROUGH GRADING

A. Excavate all soil from areas to be affected, and within the limits of grading.
B. Tolerance of Subgrade: Plus or minus two (2) inches.

12.1 EXCAVATION & TRENCHING

A. Excavation shall not be classified but will include all material.
B. Excavate soil required to accommodate site fill, paving, utility lines and construction operations.
C. Remove lumped subsoil, boulders, rock, and buried debris. Use mechanical method for rock removal. Blasting is not permitted.
D. Use of excavated material for fill is required. Excavated fill, not used to establish grade within the site shall be hauled to the stockpile area identified on the Improvement Plans.

E. To minimize disturbance of the surrounding site, all vehicular and machinery access during the construction will occur along the proposed path routes.
F. Any rigid materials shall be removed to a depth of 4" below bottom of same to allow for reshaping this material. These materials shall be hauled off site to an acceptable disposal area.

## 13.1 SUBGRADE PREPARATION AND PROTECTION

A. Excavate existing subgrade to proposed subgrade elevations as indicated, to accommodate proposed granular fill.
B. Remove and replace unsuitable soils in accordance with paragraph "Filling and Backfilling."
C. Subgrade areas which become unsuitable due to increase or decrease in moisture content will be dried or wetted, as necessary, and re-compacted prior to continuation of Work.
D. Transition area: Cut and at-grade section adjacent to the fill areas, will be scarified to a depth of six (6) inches and will be compacted to a degree equal to that of the adjacent fill material.

## 14.1 FILLING AND BACKFILLING

A. Filling and backfill will not begin until construction below finish grade has been approved and the excavation cleared of trash and debris.
B. Fill and backfill areas to contours and elevations indicated with unfrozen materials that have been approved for use by the Owners representative.
C. Systematically fill and backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
D. Each layer of fill will be disked sufficiently to break down oversized clods, to secure a relatively uniform moisture content and density, and to facilitate proper compaction.
E. Granular Fill and Backfill: Place and compact materials in continuous layers not exceeding eight (8) inches loose thickness when compacted with heavy roller, and not exceeding six (6) inches loose thickness when compacted with hand-operated tampers.
F. Employ a placement method that does not disturb or damage protective cover and utilities in trenches.
G. Install metallic lined, printed plastic early warning tape with the words of the buried utility stenciled on the tape every 24 inches at a depth of 12 inches above the buried utility.
H. Maintain optimum moisture content of fill and backfill materials to attain required compaction density.
I. Use hand-operated equipment for compacting backfill adjacent to retaining and foundation walls and stairs.
J. Tolerance of top surface of fill or backfill: Plus one inch or minus two inches from required subgrade elevations.
K. Do not backfill over any areas that are porous, wet, frozen, or spongy subgrade surfaces.
L. Earthen Fill All references to ASTM and AASHTO specifications apply to the most recent version.

    a. Material - fill material shall be taken from approved designated borrow areas. It shall be free of roots, stumps, wood, rubbish, and stones greater than 4”, frozen or other objectionable materials. Fill material shall conform to Unified Soil Classification GC, SC, CH, or CL and must have at least 30% passing the #200 sieve. Consideration may be given to the use of other materials in embankment conditions if designed and approved by a geotechnical engineer. Such special designs must have construction supervised by a geotechnical engineer.

b. Materials used in the outer shell of embankment areas must have the capability to support vegetation of the quality required to prevent erosion of the embankment.
c. Placement - Areas on which fill is to be placed shall be scarified prior to placement of fill. Fill materials shall be placed in maximum 8 inch thick (before compaction) layers which are to be continuous over the entire length of the fill. The most permeable borrow material shall be placed in the downstream portions of the embankment. Spillways must be installed concurrently with fill placement and not excavated into the embankment.

i. Compaction - The movement of the hauling and spreading equipment over the fill shall be controlled so that the entire surface of each lift shall be traversed by not less than one tread track of heavy equipment or compaction shall be achieved by a minimum of four complete passes of a sheepsfoot, rubber tired or vibratory roller. Fill material shall contain sufficient moisture such that the required degree of compaction will be obtained with the equipment used. The fill material shall contain sufficient moisture so that if formed into a ball it will not crumble, yet not be so wet that water can be squeezed out. When required by the reviewing agency the minimum required density shall not be less than 95% of maximum dry density with a moisture content within ±2% of the optimum. Each layer of fill shall be compacted as necessary to obtain that density, and is to be certified by the Engineer at the time of construction. All compaction is to be determined by AASHTO Method T-99 (Standard Proctor).

M. Structure Backfill

a. Backfill adjacent to pipes or structures shall be of the type and quality conforming to that specified for the adjoining fill material. The fill shall be placed in horizontal layers not to exceed four inches in thickness and compacted by hand tampers or other manually directed compaction equipment. The material needs to fill completely all spaces under and adjacent to the pipe. At no time during the backfilling operation shall driven equipment be allowed to operate closer than four feet, measured horizontally, to any part of a structure. Under no circumstances shall equipment be driven over any part of a concrete structure or pipe unless there is a compacted fill of 24” or greater over the structure or pipe.
b. Structure backfill may be flowable fill meeting the requirements of Pennsylvania Department of Transportation, State Highway Administration Standard Specifications for Construction and Materials. The mixture shall have a 100-200 psi; 28 day unconfined compressive strength. The flowable fill shall have a minimum pH of 4.0 and a minimum resistivity of 2,000 ohm-cm. Material shall be placed such that a minimum of 6” (measured perpendicular to the outside of the pipe) of flowable fill shall be under (bedding), over and, on the sides of the pipe. It only needs to extend up to the spring line for rigid conduits. Average slump of the fill shall be 7” to assure flowability of the material.
c. Adequate measures shall be taken (sand bags, etc.) to prevent floating the pipe. When using flowable fill, all metal pipe shall be bituminous coated. Any adjoining soil fill shall be placed in horizontal layers not to exceed four inches in thickness and compacted by hand tampers or other manually directed compaction equipment. The material shall completely fill all voids adjacent to the flowable fill zone. At no time during the backfilling operation shall driven equipment be allowed to operate closer than four feet, measured horizontally, to any part of a structure. Under no circumstances shall equipment be driven over any part of a structure or pipe unless there is a compacted fill of 24” or greater over the structure or pipe. Backfill material outside the structural backfill (flowable fill) zone shall be of the type and quality

conforming to that specified for the core of the embankment or other embankment materials.

## 15.1 COMPACTION REQUIREMENTS

A. Compaction testing will be performed in accordance with ANSI/ASTM D698 by an independent testing firm procured by the Contractor and subject to approval by the Owner.
B. The contractor is required to perform compaction tests as requested by the Owners representative. At a minimum, one compaction test should be conducted for areas with up to 40 consecutive parked cars, for earthen berm areas that exceed 3 feet in height and/or 50 feet in length and for any foundations/abutments where multiple tests may be required depending upon the proposed structure. Additional testing locations may be required during construction due to abnormal soil conditions or as determined by the Owners Representative.
C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.
D. Compact each layer of fill and backfill to not less than the following percentages of maximum laboratory density:
    a. Pedestrian Paving: 95%
    b. Vehicular Paving and Embankment Areas: 98%
    c. Lawn Areas and General Site Fill: 92%
E. Fill areas shall be placed in layers not more than eight (6) inches in thickness, each layer thoroughly compacted by means approved by the Owners Representative. Compaction shall be required as stated above and as determined/tested by ASTM D-698. All materials utilized for fill shall be free of roots, woody vegetation, oversized stones, rocks or other objectionable materials and shall be approved by the Owners Representative.

## 16.1 CARE OF WATER DURING CONSTRUCTION

A. All work on permanent structures shall be carried out in areas free from water. The Contractor shall construct and maintain all temporary berms, levees, cofferdams, drainage channels, and stream diversions necessary to protect the areas to be occupied by the permanent works.
B. The contractor shall also furnish, install, operate, and maintain all necessary pumping and other equipment required for removal of water from various parts of the work and for maintaining the excavations, foundation, and other parts of the work free from water as required or directed by the owner and their representatives.
C. After having served their purpose, all temporary protective works shall be removed or leveled and graded to the extent required to prevent obstruction in any degree whatsoever of the flow of water to the spillway or outlet works and so as not to interfere in any way with the operation or maintenance of the structure. Stream diversions shall be maintained until the full flow can be passed through the permanent works. The removal of water from the required excavation and the foundation shall be accomplished in a manner and to the extent that will maintain stability of the excavated slopes and bottom required excavations and will allow satisfactory performance of all construction operations.
D. During the placing and compacting of material in required excavations, the water level at the locations being refilled shall be maintained below the bottom of the excavation at such locations which may require draining the water sumps from which the water shall be pumped.

17.1 STABILIZATION

A. All borrow areas shall be graded to provide proper drainage and left in a pre-excavation condition. All exposed surfaces of the embankment, spoil and borrow areas, and berms shall be stabilized by seeding, liming, fertilizing and mulching in accordance with the Natural Resources Conservation Service Standards and Specifications for Critical Area Planting.

18.1 STRIPPING OF TOPSOIL

A. Any topsoil that shall be stripped shall be done to a depth of at least 6” or a depth necessary to strip all topsoil from all areas to be impacted under the grading operations. Roots exposed and or damaged during grading shall be cut off cleanly inside the exposed or damaged area.
B. All stockpiled topsoil shall be used on the site as specified. The topsoil is the property of the owner and shall not be removed from the site.
C. As soon as the topsoil is stockpiled, the contractor shall sow the stockpiles with fresh and clean new crop annual rye grass seed delivered in the original, unopened package.
D. Stripping of the topsoil shall be completed before any demolition and immediately after clearing, grubbing, and tree protection.
E. All cleared and grubbed material shall be disposed of offsite.

19.1 TRENCHING

A. Excavate subsoil for utility piping
B. Cut trenches sufficiently wide to enable installation of utilities and allow inspection.
C. Shoring will be furnished and installed, if necessary to protect workmen, banks, structures and utilities. Shoring will be removed, as excavations are backfilled, in a manner to prevent cave-ins.
D. Hand trim excavation. Remove loose matter. Utilities will bear on bedding materials, as specified, at all points along their entire length.
E. Remove lumped subsoil, boulders and rock. Over excavate a minimum of 6 inches and backfill with granular material where rock is encountered at utility subgrade.
F. Correct unauthorized excavation at no cost to Owner. Correct areas over-excavated in accordance with paragraph "Filling and Backfilling," using granular backfill or as directed by the Owner’s Representative.
G. Support pipes during placement and compaction of bedding fill.
H. Backfill trenches to contours and elevations with unfrozen materials. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
I. Methods and compaction of backfill will conform to previously specified requirements and limits.
J. Use hand-operated compaction equipment until cover over utility is a minimum of one feet thick or as shown in the drawings.
K. Install metallic lined, printed plastic early warning tape with the words of the buried utility stenciled on the tape every 24 inches at a depth of 12 inches above the buried utility.

20.1 FINISH GRADING

A. Prior to paving, topsoiling, or other construction, grade and compact previously graded and backfilled areas that have been disturbed by construction operations.
B. Grade lawn areas to within four inches of proposed finished grade to allow for 2" minimum of topsoil placement.

C. Grade paved areas to the drainage slopes shown to plus zero (0) or minus one (1) inch of proposed subgrade elevation.
D. All slopes, unless otherwise indicated, shall be uniform without abrupt changes between any two elevations shown on Plan.
E. In all grass areas, the subgrade shall be brought to finish grade not less than the topsoil depth indicated in the Fine Grading and Seeding specification, to allow for the spreading of topsoil.

DIVISION 31 - EARTHWORK
SECTION 31 25 00 - EROSION & SEDIMENT CONTROL

## 1.1 SCOPE OF WORK

A. The Contractor shall supply all labor, tools, equipment, materials, and services necessary to install the erosion and sedimentation control devices shown in the drawings and/or as described in this specification, to perform their continued repair and maintenance during construction, and remove all devices and make necessary repairs upon completion of work. A copy of the approved erosion and sedimentation control plan shall be always on site and available.

## 1.2 MATERIALS

A. Stakes, Markers
B. Compost Filter Sock
    a. 2”x2” wood stakes
    b. filter sock - 12”, 18”, 24” diameter
C. Erosion Control Blanket/Mat
    a. jute or coir matting - 1/4”in. thick for 3:1 slope
    b. stakes/staples
D. Inlet Protection Filter Bag
E. Trench Drain Temporary Seal
F. Rock Construction Entrance with Wash Rack
    a. AASHTO #1 rock
    b. geotextile fabric
G. Concrete Washout
    a. 2”x2” wood stakes
    b. 24” diameter filter sock
H. Pumped Water Filter Bag
I. Rock Filter Outlet
    a. AASHTO #57
    b. filter fabric
    c. wood post
J. Riprap Apron
    a. geotextile fabric
    b. R-4 stone
K. Topsoil Stockpile
    a. 12” diameter filter sock
L. Orange Construction Fence
    a. 4’ height safety fence
    b. 2”x2” stakes
    c. wire fasteners
M. Wash rack, by Job Site Products (800) 298-4900, or equal

## 1.3 EXECUTION

A. Contractor shall mark the limit of disturbance shown on the plans, prior to any site work.
B. Orange construction fencing shall be installed before all other construction activity around trees to be preserved, existing wetlands, and proposed stormwater basin areas.
C. All erosion and sedimentation control devices shall be installed as identified on the erosion control plans, detail drawings and notes.

D. The contractor shall be responsible for the restoration and re-seeding of any disturbance of the site as identified within the construction drawings. Where erosion control blanket is needed the contractor shall apply seeding before installing the blanket.
E. Vehicles and trucks may access the site only from the designated construction entrances along Moyer Road only.
F. Practice good earthwork procedures to limit erosion of graded areas. Work should be conducted during appropriate weather conditions and coordinated so that seeding operations can immediately commence. Finish tracks of grading equipment will run parallel to contours.

## 1.4 MAINTENANCE AND REPAIRS

A. The contractor shall be responsible for the restoration and re-seeding of any disturbance of the site, beyond the limits of grading shown on the plans, as identified on the construction drawings.
B. Sediment and erosion control practices will not function properly throughout their designed life span if they are not maintained. Periodic inspection shall be made, and repairs shall be undertaken, at the intervals identified on the detailed drawings and E&S notes.
C. Most storm structures require work to restore them after each storm. Accumulated silt will be spread over areas disturbed by construction in this project. This maintenance will be performed to allow the structure to continue to perform the function for which it was designed, and includes but not limited to:

    1. Repairs to damaged/washed away compost filter socks/stakes.
    2. Repair to erosion control mating/staples if removed or damaged.
    3. Repair to tire scrubber will include removal, as necessary, and additional stone to make functionally effective.
    2. Cleanout of bottom of inlets of any accumulated silt material.
    3. Seeding as required as a result of maintenance.
    4. Repairs to damaged tree protection/construction fence.

## 1.5 DEVICE REMOVALS

A. The Contractor shall remove all sediment and erosion control devices when 70% vegetative cover established, or after the completion of construction, as identified on the detail drawings, construction sequence note and directed by the Owner’s Representative.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 12 16 – FURNISHING AND INSTALLATION OF ASPHALT PAVING

1.1 SCOPE OF WORK

Provide necessary labor, tools, materials, and services to furnish and install the asphalt paving at the locations indicated on the plans. The scope of work includes soil excavation and site preparation to install the asphalt paving.

1.2 MATERIALS

The materials to be used in this work shall comply with PennDOT Specifications Publication 408 dated (most recent edition), unless otherwise indicated.

A. Bituminous Pavement
   a. Subbase: 10" (Heavy Duty Pavement), 6" (Standard Pavement) - No. 2A Modified Stone
   b. Base: 4.5" PADOT 25 mm. mix (Heavy Duty Pavement)
   c. Bituminous Binder Course:
      3" Superpave 19 mm. mix (Heavy Duty Pavement)
      2.5" Superpave 19 mm. mix (Standard Pavement)
   d. Bituminous Wearing Course: —2"- Superpave 9.5mm
   e. Bituminous Tack Coat - one of the following should be used: :

| Class | Type | Min. | Max. |
|---|---|---|---|
| E-1 | Emulsified Asphalt | 70 | 150 |
| E-6 | " | 70 | 150 |
| E-8 | " | 70 | 150 |

   f. Woven geotextile fabric with a monofilament weave for higher tensile strength
   g. Crushed aggregate base stone: Rip-Rap R-3
   h. White/Blue Paint (Type II) Low-heat, rapid-dry paint, Section 962.1 of PennDOT Specifications.
   i. Class J-1 bituminous liquid sealant

B. Trail Paving (including storm pipe)
   a. Pipe bedding: 4" AASHTO #57 coarse aggregate
   b. Storm pipe: 8" diameter HDPE
   c. Pipe cover: 16" No. 2A Modified stone
   d. Subbase: 4" 2A Modified stone
   e. Wearing course: 2.25" PADOT 9.5mm

1.3 EXECUTION

A. Preparation of Subgrade: Subgrade shall be excavated to the required elevations and compacted in accordance with Section 108.05 (c) of PennDOT Specifications. The contractor shall compact the unexcavated areas in accordance with Section 108.05 (c) of PennDOT Specifications. Unsuitable subgrade material, if encountered, shall be excavated by the Contractor and replaced with a crushed aggregate base course to a depth as directed and as shown on detail drawings. Woven geotextile fabric shall be installed across the entire

area of unsuitable soils with 12 inches of overlap between sections.

B. Sub-Base Course: After the subgrade has been compacted, the Contractor shall spread a 2A Modified base course of stone to a depth as identified above and on the detail drawings. The stone shall be spread uniformly over the subgrade with approved mechanical equipment. It shall not be placed on wet, frozen, or unsuitable subgrade. In areas inaccessible to spreading equipment, the engineer may permit manual spreading which shall be performed in a sweeping motion with a square-pointed shovel, alternately in opposite directions, until the voids are completely filled. Base course shall then be compacted in accordance with Section 108.05 (c) of PennDOT Specifications, and at the appropriate elevations for the base course material.
C. The bituminous concrete base course (Heavy Duty Paving only) shall consist of hot-mixed, hot-laid Superpave 25 mm in accordance with these specifications, PennDOT specifications and within the lines, grades, and width and to a compacted depth of 4.5 inches
D. The bituminous concrete binder course shall consist of hot-mixed, hot-laid Superpave 19 mm in accordance with these specifications, PennDOT specifications and within the lines, grades, and width and to a compacted depth of 3 inches (Heavy Duty) and 2.5 inches (Standard).
E. Application of the bituminous tack coat shall be in accordance with Section 460.3 of PennDOT specifications. Tack coat shall be applied to asphalt surfaces that have been installed for more than 30-days or have lost their ability to bind with the surface/wearing course. Tack coat shall not be allied to newly installed binder paving.
F. Bituminous Wearing Course: The Bituminous concrete wearing course shall consist of hot-mixed, hot-laid Superpave 9.5mm asphalt concrete with aggregate according to description for wearing course in accordance with Section 421, PennDOT Specifications and within the lines, grades, and width and to a compacted depth of 2 inches (Heavy Duty/Standard) and 2.25” (Trail).
G. Joints: All longitudinal and transverse joints in the wearing courses shall be carefully constructed and sealed to provide a smooth riding surface. All joints shall be sealed by hot bituminous liquid conforming to Bulletin 27 PennDOT Specifications. Sealer shall be applied with brush or spray. All uncoated or lightly coated areas shall be satisfactorily corrected with the application of additional sealer.
H. Sealing Joints: The Contractor shall seal all joints where the bituminous pavement abuts existing pavement. Material shall be Class J-1, hot bituminous liquid conforming to Bulletin 25 of PennDOT Specifications. All vertical joint surfaces shall be sealed immediately prior to paving with Binder and/or Wearing Course. Poured joint-sealing material shall not be placed when the prevailing air temperature is less than 40 degrees F, unless approved by the Owners Representative. Care shall be taken to prevent the sealing material from spreading over the surface of the pavement. All excess joint sealing material shall be removed from the surface of the pavement.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 17 23 – PAVEMENT MARKINGS

1.1 SCOPE OF WORK

The Contractor shall provide the necessary tools, labor, equipment, and materials necessary to supply and install the pavement markings and all incidentals as shown in the plan/detail drawings and as manufacturer's specification.

2.1 REFERENCED STANDARDS

Penn DOT: Pennsylvania Department of Transportation Specifications - Publication 408, most recent edition

3.1 QUALITY ASSURANCE

Codes and Standards: Comply with State governing regulations if more stringent than specified.

4.1 REGULATORY REQUIREMENTS

Comply with applicable provisions of codes, standards and specifications referenced in this section.

5.1 MATERIALS

A. Lane Marking Paint: Type II, low heat, rapid dry material meeting the requirements of Penn DOT Publication 408, Section 962.
B. Cold Plastic Pavement Markings: Cold plastic pavement markings and legends meeting the requirements of Penn DOT Publication 408, Section 1103.14 (a).

6.1 EXECUTION

A. Cleaning: Sweep and clean surface to eliminate loose material and dust.

B. Striping: Use Type II, low heat, rapid drying material.

   a. Color: White (Pavement Legend, Stop Bar, Parking Stall), Yellow (Driveway), and Azure Blue (ADA accessible parking).

   b. Do not apply traffic and lane marking paint until layout and placement has been verified with the Owners Representative.

   c. Apply paint with mechanical equipment to produce uniform straight edges. Apply in 2 coats at manufacturer's recommended rates.

C. Pavement Markings and Legends: Apply stop bars and other pavement markings and legends as part of the wearing course placement just before final compaction (in-laid application).

D. All work shall be performed in accordance with Penn DOT Publication 408, Sections 961 and 962.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 18 23 – CONCRETE BUMPER BLOCK

## 1.1 SCOPE OF WORK

The Contractor shall provide the necessary tools, labor, equipment, and materials necessary to furnish and install the concrete bumper blocks (or Equal) as shown on the drawings.

## 1.2 MATERIALS

A. 4000 PSI concrete bumper blocks as supplied by Nitterhouse Masonry Products, LLC, or equal. Phone: (717) 268-4137
B. #4 rebar, 2 feet length
C. Epoxy Resin

## 1.3 EXECUTION

A. Position the parking block in the parking lot as shown on detail drawings. Using the holes molded in the parking block as templates, mark the location of each hole on the asphalt surface.
B. Remove the parking block. Using a high-speed hammer drill with a 7/16" masonry bit, drill a pilot hole at each marked location:
   - To avoid fracturing the asphalt with the spike
   - To make it easier to drive the spikes in during installation.

   Note: If you are working with either a thin layer of asphalt or a soft substrate, you may want to ‘cover’ each spike with a small amount of activated epoxy resin immediately before driving the spike in place. This will help hold the parking block flat.

C. Reposition the parking block so that the molded in holes line up vertically with the drilled pilot holes. Starting with the center hole, use the hammer to drive the spikes through the parking block until the head of the spike is snug against the counter bored holes in the parking block. DO NOT DRIVE BEYOND "SNUG"! If driven too far, the spikes or hammer may damage the parking block and will void the product warranty.

## 1.4 CLEANING

A. Clean up debris and unused material and remove from the site.

DIVISION 32 SITE IMPROVEMENTS
SECTION 32 31 13 CHAIN LINK FENCES AND GATES

## 1.1 SCOPE OF WORK

Provide necessary labor, tools, equipment, materials, and services to furnish and install the galvanized chain link fencing and accessories.

## 1.2 SUBMITTALS

A. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.

B. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.

C. Samples: Samples of materials (e.g., fabric, wires, and accessories).

## 2.1 MATERIALS

A. Products from qualified manufacturers having a minimum of five years' experience manufacturing thermally fused chain link fencing will be acceptable by the Owner's Representative as equal if they meet the following specifications for design, size gauge of metal parts, and fabrication.

## 2.2 CHAIN LINK FENCE FABRIC AND SCREEN

A. Chain link fabric shall be supplied with knuckles on both ends.

B. Mesh for 9-gauge measures 2". ". Mesh size is the measured distance between two parallel sides.

C. Mesh height shall be 6' feet (see Improvement Plan)

D. PVC coating thermally fused to zinc-coated or zinc-5% aluminum-mischmetal alloy-coated steel core wire: ASTM F 668 Class 2b, 7 mil thickness thermally fused. Core wire tensile strength 75,000 psi., black color

E. Noodle Link Plus privacy slats as manufactured by Privacy Link (800) 574-1076, info@eprivacylink.com), or equal.

## 2.3 STEEL FENCE FRAMING

A. Posts shall be supplied 2-1/2' longer than the height of fence being installed, The 6' high fence shall be supplied with 8-1/2' long posts.

B. Posts shall be 3" O.D. (6' height fence) Schedule 40 galv. Aluminum with a 0.110 minimum thickness and a minimum yield strength of 50,000 psi. with a bending moment of 9,107 lbs./in.

C. Rails shall be 1-5/8” O.D. Schedule 40 galv. Aluminum with a 0.110 minimum thickness and a minimum yield strength of 50,000 psi. with a bending moment of 9,107 lbs./in.

D. Code certifications: AASHTO M181-93, ASTM Specifications A 569 & F-1043-95 and Chain Link Fence Manufacturers Institute Product Manual.

E. PVC-Coated finish: In accordance with ASTM F1043, apply supplemental color coating of 10 to 15 mils of thermally fused PVC in BLACK color to match fabric..

2.4 ACCESSORIES

A. Post caps: Formed steel, cast malleable iron, or aluminum alloy weathertight closure cap for tubular posts. Provide one cap for each post

B. Brace Bands – Formed steel brace bands shall be used to attach rail end cups and tension wire to terminal posts during installation. Brace Bands shall be supplied flat (not beveled).

C. Top rail and brace rail ends: Formed steel for connection of rail and brace to terminal posts.

D. Wire ties: 10-gauge galvanized steel wire for attachment of fabric to line posts; 10-gauge for rails and braces. Hog ring ties of 12-1/2 gauge for attachment of fabric to tension wire.

E. Brace and tension (stretcher bar) bands: Pressed steel.

F. Tension (stretcher) bars: One-piece lengths equal to 2 inches less than full height of fabric with a minimum cross-section of 3/16” x 3/4”. Provide tension (stretcher) bars where chain link fabric meets terminal posts or change in the direction of the fence.

G. All accessories, including nuts and bolts are to be supplied powder coated or painted black to match posts and mesh per ASTM D 3451– 01 and D 4217-07.

2.5 SETTING MATERIALS

A. Concrete: Minimum 28-day compressive strength of 3,500 psi

2.6 EXAMINATION

A. Verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries of work are clearly established.

3.1 CHAIN LINK FENCE FRAMING INSTALLATION

A. Install chain link fence in accordance with ASTM F 567 and manufacturer’s instructions.

B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30° or more.

C. Space line posts uniformly at 8’ on center.

D. Concrete set all posts: Drill holes in firm, undisturbed or compacted soil. Hole dimensions shall be as per the detail drawings. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 30” below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post. Slope to direct water away from posts. In areas where an obstruction or large rock may be unearthed, preventing the installation of the terminal gate posts, the Owner’s Representative shall be notified to provide an alternate solution.

E. Check each post for vertical and top alignment and maintain in position during placement and finishing operations.

F. Bracing: Install horizontal pipe brace at mid-height on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.

G. Top & bottom rails: Install rails. Connect joints with sleeves for rigid connections for expansion/contraction.

3.2 CHAIN LINK FABRIC INSTALLATION

A. Fabric: Install fabric on exterior side and attach so that fabric remains in tension after pulling force is released. Leave approximately 0.5” between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 14” on center and to rails, braces, and tension wire at 24” on center.

B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15” on center.

C. Noodle Link Plus privacy slats shall be installed per the manufacturers specifications if mesh fabric is not purchased with the privacy slats pre-installed.

3.3 ACCESSORIES

A. Tie wires: 10-gauge wire ties shall be twisted for all rails and then bent tightly against the rail so that the bend is parallel with the rail. All twisted ties shall not pose a hazard to pedestrians or clothing. The wire ties shall be installed on the rails so that they do not deform the fabric, capture more than one wire strand of the fabric nor mar the surface of the fabric. 11-gauge wire ties shall be bent around the posts and loop bent onto the fabric. Loops shall be closed upon the fabric without causing damage to the mesh. The contractor shall be responsible for replacing any damaged fabric in entirety.

B. Fasteners: Install nuts on side of fence opposite fabric side for added security.

3.4 CLEANING

A. Clean up debris and unused material and remove from the site.

DIVISION 32 EXTERIOR IMPROVEMENTS
SECTION 32 31 19 DECORATIVE AND CHAIN LINK METAL GATES

## 1.1 SCOPE OF WORK

The contractor shall provide all labor, materials and appurtenances necessary for installation of the industrial ornamental aluminum fence system defined herein at the Upper Pottsgrove Municipal Complex.

## 1.2 RELATED SECTIONS

| | |
|---|---|
| 31 25 00 | Earthwork |
| 03 30 00 | Concrete |
| 32 31 13 | Chain Link Fencing |

## 1.3 SUBMITTALS

A. Shop drawings: Submit Shop Drawings to the Owner's Representative for fabrication and installation of ornamental metal work. Include plans, elevations, and detailed sections. Indicate materials, methods, finishes, and types of joinery, fasteners, anchorages, sleeves, and bolts to be installed by others. Shop drawings to be field verified by installer.

B. Comply with applicable (Federal/State/Local) code and project standards.

## 1.4 QUALITY ASSURANCE

A. Gate Installer Qualifications: An experienced installer who has completed fences and gates of similar work for material, design to the extent of those indicated for the project, with successful results of lasting construction.

B. Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

## 2.1 MATERIALS

A. Ornamental Pivot Gate
B. Chain-link Pivot Gate
C. Chain-link Cantilevered Sliding Gate
D. Hive Receiver, Model 300/310 Wireless receivers, Qty: 3
E. Stinger Programmable 2-button and 1-button visor mounted transmitters, Qty: 8 ea. 1-button transmitter is specified for the alternate rolling gate.
F. Dolphin Access Systems keypad with extended support arm, Qty: 2
G. Noodle Link Plus privacy slats (chain link gate) as manufactured by Privacy Link (800) 574-1076, info@eprivacylink.com), or equal.

H. 6' Ornamental Fence Privacy Slats Kit For 1-1/2" Sq. Pickets as manufactured by Quick Ship Aluminum Fence (888) 378-1096, or equal

2.2 MANUFACTURERS

A. Tymetal Corporation.
    a. Cantilevered Chain Link Gate: TYM-SL-2000DC HEAVY DUTY CONTAILEVERED SLIDE GATE SYSTEM (CHAINLINK). As manufactured by TYMETALS in Greenwich, NY.
    b. Specifications
        i. Maximum gate panel weight: 2,000 pounds
        ii. UL 325 and 991 compliant with ETL listing
        iii. Rated for continuous duty – UL Classes I, II, III and IV
        iv. Battery backup system with two 7-AH 12VDC batteries
        v. Continuous duty, brushless motor
        vi. Speed: 12 inches per second
        vii. Gear Box Ratio: 20:1
        viii. Temperature Range: -40° to 160°
        ix. Chain Size: 41NP
        x. Power Input: 115 VAC, 50/60Hz single phase – 6 Amps; 230 VAC, 50/60Hz single phase – 3 Amps; 24 VAC solar panel up to 80 watts
        xi. Warranty: 3 year gate and operator – commercial
        xii. Made in USA
B. Autogate gate entry system
    a. VPG-24 BUCKEYE 500 Ornamental Gate including all operating controls and dbl. top and bottom rails.
    b. VPG-24 CHAINLINK 300 including all operating controls
C. Transmitter/Receivers
    a. HIVE Receiver Model: 300/310 MHz Receiver, Frequency 300 MHz
    b. STINGER Transmitter Model: 300MCD22V2 (Double Button), Frequency 300 MHz
    c. STINGER Transmitter Model: 300MCD21V2 (Single Button), Frequency 300 MHz
D. Access System
    a. Keypad Model: DOLKWP300318, Frequency 300 MHz

3.1 DECORATIVE METAL GATE INSTALLATION

A. The Contractor shall furnish shop drawings from the equipment manufacturer detailing specifications, finish, method of fastening, mounting and installation. All

gates, including accessories, shall be installed as per the manufacturer's specifications. All materials shall be as specified.

B. The contractor shall install decorative gates as shown on the detail drawings and according to the manufacturer’s specifications.

DIVISION 32
SECTION 32 31 19.0 – ORNAMENTAL METAL FENCE

1.01 SCOPE OF WORK

The contractor shall provide all necessary tools, labor, materials and equipment necessary to install ornamental picket fencing (including accessories), as illustrated on the plans, details and specifications.

1.02 SUBMITTALS:

A. Changes in specification may not be made after the bid date.

B. Shop Drawings: Layout of fence and gates and railing with dimensions, details and finishes of component accessories and post foundations.

C. Product Data: Manufacturer's catalogue cuts indicating material compliance and specified options.

D. Samples: Color selections for polyester finishes and materials, (e.g. finials, caps, and accessories).

2.01 Manufacturer:

A. The fencing shall be Industrial Strength Aluminum Ornamental Fence as manufactured by Jerith Manufacturing Co., Inc., 14400 McNulty Road, Philadelphia, PA 19154. (Telephone: 800-344-2242; Fax: 215-676-9756; email: sales@jerith.com.) or approved equal. The fence shall be Jerith Echelon style with a picket length of 6 feet and a dbl. top and bottom rail. The powder coat colors of the fence system shall be dark bronze satin.

B. 6' Ornamental Fence Privacy Slats Kit For 1-1/2" Sq. Pickets as manufactured by Quick Ship Aluminum Fence (888) 378-1096, or equal

2.02 Materials:

A. Fence Aluminum Extrusions: All posts and rails used in the fence system shall be extruded from HS-35™ aluminum alloy having a minimum yield strength of 35,000 psi. All pickets shall have a minimum yield strength of 25,000 psi. 6063-T5 Alloy is not acceptable for any components.

B. Fence Fasteners: All fasteners shall be stainless steel. Square drive screws shall be used to connect the pickets to the horizontal rails. Rail to post connections shall be made using self-drilling hex-head screws.

C. Fence Accessories: Aluminum sand and die castings shall be used for all scrolls, post caps, finials, and miscellaneous hardware. Die castings shall be made from Alloy 360.0 for superior corrosion resistance. Alloy 380.0 is not acceptable.

D. Railing Posts: Vert. elements 1-1/2 dia." tubular steel, gauge.060".

E. Railing Rails: Horiz. elements 1-1/2" dia. tubular steel, gauge.060".

F. Railing Color: Black, Polyester Powder Coat, ASTM B 3363, D2793

2.03 Finish:

A. Fence Pretreatment: A three stage non-chrome pretreatment shall be applied. The first step shall be a chemical cleaning, followed by a water rinse. The final stage shall be a dry-in-place activator which produces a uniform chemical conversion coating for superior adhesion.

B. Fence coating: Fence materials shall be coated with FencCoat™, a Super-Durable TGIC polyester powder-coat finish system. Epoxy powder coatings, baked enamel or acrylic paint finishes are not acceptable. The FencCoat finish shall have a cured film thickness of at least 2.0 mils. In addition, the screw heads shall be painted to match the color of the fence.

C. Tests: The cured Fence Coat finish shall meet AAMA 2604 "Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels", which includes the following requirements:

   a. Humidity resistance of 3,000 hours using ASTM D2247.

   b. Salt-spray resistance of 3,000 hours using ASTM B117.

   c. Outdoor weathering shall show no adhesion loss, checking or crazing, with only slight fade and chalk when exposed for 5 years in Florida facing south at a 45 degree angle. Finishes which only meet AAMA 2603 (or the previous version - AAMA 603) are <u>not</u> acceptable.

2.04 Fence/Gate Construction:

A. Horizontal rails shall be $1\frac{5}{8}$" channels formed in a modified "U" shape. Pickets shall pass through holes punched in the top of the rail. The top wall shall be .070" thick and the side walls .100" thick for superior vertical load strength. There shall be 3 horizontal rails (3 rails for 6' high fence) in each section.

B. Pickets shall be fastened to the rails using painted stainless steel screws. Screws shall be used on only one side of the rail, leaving the other side with a clean appearance. Pickets shall be 1" square and have a wall thickness of .062". Welding the pickets to the rails is not permitted.

C. Posts shall be 2½" square extrusions with pre-punched holes which allow the fence section rails to slide in. Posts shall be spaced 34½" on center and have .075" walls. Gate posts shall be [4" or 6"] square with .125" walls and used on both sides of a gate. Die cast aluminum caps shall be provided with all posts.

D. Assembled sections shall support a 1,000 lb. vertical load at the midpoint of any horizontal rail.

E. The Jerith logo shall appear on all post caps, gates, and horizontal rails of the fencing system.

F. Welding:
   a. Before welding aluminum, clean the base material to remove any aluminum oxide and hydrocarbon contamination from oils or cutting solvents. Use a stainless-steel bristle wire

brush or solvents and etching solutions. When using a stainless-steel brush, brush only in one direction. Take care to not brush too roughly: rough brushing can further imbed the oxides in the work piece. Also, use the brush only on aluminum work-don't clean aluminum with a brush that's been used on stainless or carbon steel. To minimize the risk of hydrocarbons from oils or cutting solvents entering the weld, remove them with a degreaser. Check that the degreaser does not contain any hydrocarbons.

b. Preheating the aluminum workpiece to avoid weld cracking. Preheating temperature should not exceed 230 F-use a temperature indicator to prevent overheating. In addition, placing tack welds at the beginning and end of the area to be welded to aid in the preheating effort.

c. Welding shall per performed by pushing the gun away from the weld puddle rather than pulling it, resulting in better cleaning action, reducing weld contamination, and improving shielding-gas coverage. The Travel speed of aluminum welding must be performed "hot and fast" to eliminate burn through of the aluminum. The contractors welder shall build-up craters to form a convex or mound shaped welds. An aluminum filler wire that has a melting temperature similar to the base material shall be used for welding. The contractor shall obtain wire that is 3/64- or 1/16- inch diameter.

d. The contractor shall use a separate gun liner for welding aluminum. To prevent wire chaffing, restrain both ends of the liner to eliminate gaps between the liner and the gas diffuser on the gun. Change liners often to minimize the potential for the abrasive aluminum oxide to cause wire-feeding problems. Use a contact tip approximately 0.015 inch larger than the diameter of the filler metal being used - as the tip heats, it will expand into an oval shape and possibly restrict wire feeding. Generally, when a welding current exceeds 200A use a water-cooled gun to minimize heat buildup and reduce wire-feeding difficulties.

2.05 Warranty:

The entire fence and railing system shall have a written One-year Warranty against rust and defects in workmanship and materials. In addition, the FencCoat finish shall be warranted not to crack, chip, peel, or blister for the same period

3.01 EXAMINATION

A. Verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries of work are clearly established.

3.02 FENCE INSTALLATION

A. Install fence, and railings in accordance with manufacturer’s instructions.

B. Space posts uniformly at 34 1/2” (2356 mm) maximum face to face unless otherwise indicated.

C. Check each post for vertical and top alignment, and maintain in position during placement and finishing operation.

D. Align fence panels between posts. Firmly attach rail brackets to posts with 1/4” (6 mm) bolt and lock nut, ensuring panels and posts remain plumb.

3.03 FENCE ACCESSORIES

A. Install post caps, privacy slats and other accessories to complete fence.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 32 23 - KEYSTONE CONCRETE RETAINING WALL
(SEGMENTED RETAINING WALLS)

## 1.1 SCOPE OF WORK

A. Work shall consist of designing, furnishing and construction of a KEYSTONE Compac III unit retaining wall system in accordance with these specifications and in reasonably close conformity with the lines, grades, design and dimensions shown on the plans.
B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit facing system, unit drainage fills and reinforced backfill to the lines and grades shown on the construction drawings.
C. Work includes furnishing and installing geogrid soil reinforcement of the type, size, location and lengths designated on the construction drawings.

### 1.1.1 DEFINITIONS

A. Compac III Unit – a dry-stacked concrete retaining wall unit machine made from Portland cement, water, aggregates, manufactured by a licensed manufacturer of Keystone.
B. Structural Geogrid – a polymeric material formed by a regular network of connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
C. Unit Drainage Fill – drainage aggregate that is placed within and immediately behind the Keystone concrete units.
D. Reinforced Backfill – compacted soil that is placed within the reinforced soil volume as outlined on the plans.
E. Retained Soil – the soil mass behind the reinforced backfill.
F. Foundation Soil – the soil mass below the leveling pad and reinforced backfill.
G. Leveling Pad – crushed stone, sand and gravel or unreinforced concrete material placed to provide a level surface for placement of the Keystone concrete units.
H. Geosynthetic Reinforcement – polymeric material designed specifically for soil reinforcement.

### 1.1.2 SUBMITTALS AND CERTIFICATION

A. The contractor shall submit a Manufacturer’s certification prior to the start of work, so that the retaining wall system components meet the requirements of this specification and the structure design.
B. The contractor shall submit construction drawings and design calculations for the retaining wall system prepared and stamped by a Professional Engineer registered in the state of Pennsylvania.

### 1.1.3 QUALITY ASSURANCE

A. The contractor shall provide evidence that the design engineer has a minimum of five years documented experience in the design of reinforced soil structures. The design engineer shall

provide proof of current professional liability insurance with an aggregate coverage limit of not less than $2,000,000.

B. The owner shall/may provide quality assurance inspection and testing during earthwork and wall construction operations. The contractor shall provide all quality control testing and inspection not provided by the owner. The owner's quality assurance program does not relieve the contractor of responsibility for quality control and wall performance.

### 1.1.4 DELIVERY HANDLING AND STORAGE

A. The contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.

B. The contractor shall protect all materials from damage due to job site conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

## 1.2 MATERIALS

### 1.2.1 KEYSTONE CONCRETE RETAINING WALL UNITS

A. Compac III retaining wall units shall conform to the following architectural requirements
   1. Face color - concrete gray, unless otherwise specified. The Owner may specify standard manufacturers' color.
   2. Tri-plane or Straight Face finish - hard split in angular tri-plane or straight face configuration. Other face finishes will not be allowed without written approval of Owner.
   3. Bond configuration - running with bonds nominally located at midpoint in vertically adjacent units.
   4. Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 20 feet under diffused lighting.

B. Keystone concrete units shall conform to the requirements of ASTM C1372 - Standard Specifications for Segmental Retaining Wall Units.

C. Keystone concrete units shall conform to the following structural and geometric requirements measured in accordance with ASTM C140 Sampling and Testing Concrete Masonry Units:
   1. Compressive strength: ≥ 3000 psi (21 MPa).
   2. Absorption: ≤ 8 % for standard weight aggregates.
   3. Dimensional tolerances: ± 1/8" from nominal unit dimensions not including rough split face.
   4. Unit Size: 8" (H) x 18" (W) x 12" (D) minimum.

D. Keystone concrete units shall conform to the following constructability requirements:
   1. Vertical setback: 1/8 inch ± per course (near vertical) or 1 1/8 inch + per course, per design.
   2. Alignment and grid attachment mechanism - fiberglass pins, two per unit.
   3. The maximum horizontal gap between erected units shall be ≤ 1/2 inch.

### 1.2.2 SHEAR AND REINFORCEMENT PIN CONNECTORS

A. Shear and reinforcement pin connectors shall be 1/2-inch diameter thermoset isopthalic polyester resin pultruded fiberglass reinforcement rods to provide connection between

vertically and horizontally adjacent units and geosynthetic reinforcement, with the following requirements:

- Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum.
- Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.

B. Shear and reinforcement pin connectors shall be capable of holding the geogrid in the proper design position during grid pre-tensioning and backfilling.

1.2.3 BASE LEVELING PAD MATERIAL

A. Material shall consist of a compacted crushed stone base, sand and gravel or unreinforced concrete, as specified by the engineer.

1.2.4 UNIT DRAINAGE FILL

A. Unit drainage fill shall consist of clean 1 inch minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

| Sieve Size | Percent Passing |
|---|---|
| 1 inch | 100 |
| 3/4-inch | 75 – 100 |
| No. 4 | 0 – 10 |
| No. 50 | 0 - 5 |

B. Drainage fill shall be placed within the cores of, between, and behind the units as indicated on the design drawings. Not less than 1.3 cubic foot of drainage fill shall be used for each square foot of wall face unless otherwise specified.

1.2.5 REINFORCED BACKFILL

A. Reinforced backfill shall be free of debris and meet the following gradation tested in accordance with ASTM D-422:

| Sieve Size | Percent Passing |
|---|---|
| 1 1/2 inch | 100 |
| 3/4-inch | 75 – 100 |
| No. 40 | 0 – 60 |
| No. 200 | 0 – 35 |

Plasticity Index (PI) < 15 and Liquid Limit < 40, per ASTM D4318

B. The maximum aggregate size shall be limited to 3/4 inch unless installation damage tests have been performed to evaluate potential strength reductions to the geogrid design due to increased installation damage during construction.
C. Material can be site-excavated soils where the above requirements can be met. Soils not meeting the above criteria, including highly plastic clays and organic soils, shall not be used in the backfill or reinforced backfill soil mass.
D. The contractor shall submit reinforced fill sample and laboratory test results to the Landscape Architect/Engineer for approval, prior to the use of any proposed reinforced backfill material.

### 1.2.6 GEOGRID SOIL REINFORCEMENT

A. Geosynthetic reinforcement shall consist of geogrids manufactured for soil reinforcement applications and shall be manufactured from high tenacity polyester yarn or high-density polyethylene. Polyester geogrid shall be made from high tenacity polyester filament yarn with a molecular weight exceeding 25,000 g/m and with a carboxyl end group value less than 30. Polyester geogrid shall be coated with an impregnated PVC coating that resists peeling, cracking and stripping.
B. Ta – Long Term Allowable Tensile Design Load. Ta of the geogrid material shall be determined as follows: Ta = Tult/(RFcr * RFd * RFid * FS). Ta shall be evaluated based on a 75-year design life.
    a. Tult – Short Term Ultimate Tensile Strength. Tult shall be determined in accordance with ASTM D4595 or ASTM D6637. Tult is based on the minimum average roll values (MARV).
    b. RFcr – Reduction Factor for Long Term Tension Creep. RFcr shall be determined from 10,000 hour creep testing performed in accordance with ASTM D5262. RFcr = 1.45 minimum.
    c. RFd – Reduction Factor for Durability. RFd shall be determined from polymer specific durability testing covering the range of expected soil environments. RFd = 1.10 minimum.
    d. RFid – Reduction Factor for Installation Damage. RFid shall be determined from product specific construction damage testing performed in accordance with ASTM D5818. Test results shall be provided for each product to be used with project specific or more severe soil types. RFid = 1.05 minimum.
    e. FS – Overall Design Factor of Safety. FS hall be 1.5 unless noted for the maximum allowable working stress calculation.
C. The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection divided by a factor of safety of 1.5. The connection strength testing and computation procedures shall be in accordance with ASTM D6638 Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units or NCMA SRWU-1.
D. Ci – Coefficient of Soil Interaction. Ci values shall be determined per ASTM D6706 at a maximum 0.75 inch displacement.
E. The geogrid manufacturer shall have a Manufacturing Quality Control program that includes QC testing by an independent laboratory. The QC testing shall include Tensile Strength testing, Melt Flow Index testing for HDPE geogrids and Molecular Weight testing for polyester geogrids.

### 1.2.7 DRAINAGE PIPE

A. If required, drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M252.

### 1.2.8 GEOTEXTILE FILTER FABRIC

A. When required, geotextile filter fabric shall be a needle-punched nonwoven fabric that meets the requirements of AASHTO M288.

### 1.2.9 SLEEVE-IT SYSTEM FOR FENCE POSTS

A. Standard Sleeve-It Unitary Design for fence posting along segmental retaining wall

## 1.3 EXECUTION

### 1.3.1 EXCAVATION

A. The contractor shall excavate to the lines and grades shown on the construction drawings. The Owner or owner's representative shall inspect the excavation and test the foundation soils and approve prior to placement of the leveling pad material or fill soils. Any over-excavation required to remove unsuitable soils shall be oversized from the front of the leveling pad and back of the geogrid reinforcement.
B. Over-excavation and replacement of unsuitable soils and replacement with approved compacted fill will be compensated as agreed upon with the Owner.

### 1.3.2 BASE LEVELING PAD

A. Leveling pad material shall be placed to the lines and grades shown on the construction drawings to a minimum thickness of 6 inches and extend laterally to a minimum of 6 inches in front and behind the Keystone wall unit.
B. Soil leveling pad materials shall be compacted to a minimum of 95% of Standard Proctor density per ASTM D697 or 92% Modified Proctor density per ASTM D1557.
C. Leveling pad shall be prepared to insure full contact with the base surface of the concrete units.

### 1.3.3 KEYSTONE UNIT INSTALLATION

A. First course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and ensure that all units are in full contact with the base and properly seated.
B. Place the front of units side-by-side. Do not leave gaps between adjacent units. Layout of corners and curves shall be in accordance with manufacturer's recommendations.
C. Install shear/connecting pins per manufacturer's recommendations.
D. Place and compact drainage fill within and behind wall units. Place and compact reinforced backfill soil behind drainage fill.
E. Place Sleeve-It units in fence post locations and locks in place between concrete units and any stone or backfill. Do not cover Sleeve-it until the fence post is installed.
F. Maximum stacked vertical height of wall units, prior to drainage fill and backfill placement and compaction, shall not exceed three courses.

### 1.3.4 STRUCTURAL GEOGRID INSTALLATION

A. Geogrid shall be installed with the highest strength direction perpendicular to the wall alignment.
B. Geogrid reinforcement shall be placed at the strengths, lengths and elevations shown on the construction drawings, or as directed by the engineer.

C. The geogrid shall be laid horizontally on compacted backfill and attached to the Keystone wall unit pins and within 1 inch of the face of the units. Place the next course of Keystone units over the geogrid. The geogrid shall be pulled taut and anchored prior to backfill placement on the geogrid.
D. Geogrid reinforcements shall be continuous throughout their embedment lengths and placed side-by-side to provide 100% coverage at each level. Spliced connections between shorter pieces of geogrid or gaps greater than 2 inches between adjacent pieces of geogrid are not permitted.

### 1.3.5 REINFORCED BACKFILL PLACEMENT

A. Reinforced backfill shall be placed, spread and compacted in such a manner that minimizes the development of slack in the geogrid and installation damage to the geogrid.
B. Reinforced backfill shall be placed and compacted in lifts not to exceed 6 inches where hand operated compaction equipment is used, or 8 – 10 inches where heavy compaction equipment is used. Lift thickness shall be decreased to achieve the required density, as needed.
C. Reinforced backfill shall be compacted to a minimum of 95% of Standard Proctor density per ASTM D697 or 92% Modified Proctor density per ASTM D1557. The moisture content of the reinforced backfill material during compaction shall be uniformly distributed throughout each layer and shall be dry of optimum by 0 to 3 percentage points of moisture.
D. Only hand operated compaction equipment shall be allowed within 3 feet from the back of the Keystone concrete units.
E. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Tracked vehicle turning should be kept to a minimum to prevent tracks from displacing the fill and damaging or displacing the Keystone units or geogrid.
F. Rubber tired equipment may pass over geogrid reinforcement at slow speeds, less than 10 MPH. Sudden braking and turning shall be avoided.
G. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from the wall face. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

### 1.3.6 CAP INSTALLATION

A. Prior to placement of the cap units, the upper surface of the top course of wall units shall be cleaned of soil and any other material.
B. Cap units shall be adequately glued to the underlying wall units with an all-weather exterior construction adhesive.

### 1.3.7 AS-BUILT CONSTRUCTION TOLERANCES

A. Vertical alignment: ± 1.5 inches over any 10-foot distance.
B. Wall batter: within 2 degrees of design batter. The overall wall batter shall be ≥ 0 degrees.
C. Horizontal alignment: ± 1.5 inches over any 10-foot distance.
D. Corners and curves: ± 1 foot to theoretical location.
E. The maximum horizontal gap between erected units shall be ≤ 1/2 inch.

### 1.3.8 FIELD QUALITY CONTROL

A. Quality Assurance – The owner shall/may engage inspection and testing services, including independent laboratories, to provide quality assurance and testing services during construction. This does not relieve the Contractor from securing the necessary construction quality control testing.
B. Quality assurance should include foundation soil inspection and testing and verification of the geotechnical design parameters and verification that the contractor's quality control testing is adequate as a minimum. Quality assurance shall also include observation of the construction for general compliance with the design drawings and project specifications. Quality assurance is usually best performed by the site geotechnical engineer.
C. Quality Control – The Contractor shall engage independent inspection and testing services to perform the minimum quality control testing described in the retaining wall design plans and specifications. Only qualified and experienced technicians and engineers shall perform quality control testing and inspection services.
D. Quality control testing shall include soil and backfill testing to verify soil types and strengths, compaction and moisture conditions and verification that the retaining wall is being constructed in accordance with the design plans and specifications.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 39 13 – BOLLARD

SCOPE OF WORK

The Contractor shall provide all labor, materials, and equipment necessary to install the metal bollards including all incidentals and appurtenances as shown on the drawings and/or as specified herein.

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Division 03 Sections: Concrete

1.2 REFERENCE STANDARDS

A. ASTM A36 – Standard Specification for Carbon Structural Steel.

B. ASTM A312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

C. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

D. ASTM A536 – Standard Specification for Ductile Iron Castings.

E. ASTM B26 – Standard Specification for Aluminum-Alloy Sand Castings.

1.3 SUBMITTALS

A. Product Data: Provide for each type of bollard, component, finish, and accessory specified.

B. Color Samples: [Submit manufacturer’s standard colors for selection.]

C. Setting Drawings: Show embedded items and cutouts required for work specified in other Sections.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect bollards and accessories during delivery, storage, and handling.

PART 2 - MATERIALS

2.1 BOLLARD

A. 6” diameter steel C40 traffic bollard, crash rated to 5,000 lbs. as manufactured by the Bollard Company: https://bollardcompany.com/c40-impact-bollard. Color finish to be selected by the owner.

B. Flat top neoprene cap, as manufactured by the Bollard Company: https://bollardcompany.com/flat-top-plastic-bollard-caps. Color to be selected by the Owner

C. Concrete footing (See Section 03 30 00)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine paving or other substrates for compliance with manufacturer’s requirements for placement and location of embedded items, condition of substrate, and other conditions affecting installation of bollards.

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

3.2 INSTALLATION

A. General: Comply with manufacturer’s installation instructions and setting drawings.

B. Do not install damaged, cracked, chipped, deformed or marred bollards. Field touch-up minor imperfections in accordance with manufacturer’s instructions. Replace bollards that cannot be field repaired.

3.3 CLEANING & PROTECTION

A. Protect bollards against damage.

B. Immediately prior to Substantial Completion, clean bollards in accordance with manufacturer’s instructions to remove dust, dirt, adhesives, and other foreign materials.

C. Touch up damaged finishes according to manufacturer’s instructions.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 90 00 – LANDSCAPING

1.1 SCOPE OF WORK

Provide necessary labor, materials, equipment, tools, and services to complete the planting as shown on the detail and plan drawings and as described herein.

1.2 MATERIALS

A. Plant Materials – plant species, sizes and quantities shall be as per the plant schedule contained within the Landscape Plan.

a. Nomenclature: Plant names shall agree with the nomenclature of Standardized Plant Names as adopted by the American Joint Committee on Horticultural Nomenclature 1942 Edition. Plant names not listed therein shall conform to the names most generally recognized in the trade.

b. Measurement: Sizes and grading standards shall conform to the American Standard for Nursery Stock, ANSI 260.1-1986, sponsored by the American Association of Nurserymen, unless otherwise specified. Large plants cut back to specified size are not acceptable.

c. Quality: Plants shall be nursery grown. Plants shall be typical of their species, varieties, or cultivars. They shall have normal, well-developed branches and vigorous, fibrous root systems. They shall be sound, healthy, vigorous plants, free from defects, disfiguring knots, sun-scald injuries, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. Plants shall be grown under the same climatic conditions as the location of this project.

d. Preparation of Plants: All precautions customary in good trade practice shall be taken in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Plants shall be dug immediately before moving and in a manner to retain as many fibrous roots as possible.

e. Balled and burlapped plants shall have a solid ball of earth containing the roots securely held in place by burlap and strong cord or rope. No wire baskets are permitted. Do not use synthetic fabric or bindings for wrapping root balls. Plants with loose, broken or manufactured balls will be rejected.

B. Delivery.

a. Plants shall be packed, transported and handled with care to prevent injury.

b. Plants, which cannot be planted promptly after delivery, shall be heeled in and/or otherwise protected against drying as directed by the Landscape Architect.

c. Each shipment shall be certified by state and federal authorities to be free from disease and infestation. Any inspection certificates required by law to this effect shall accompany each shipment, invoice or order of stock and, upon arrival of the shipment, the certificate(s) shall be filed with the Landscape Architect.

C. Inspection

a. Promptly after award of the contract the contractor shall arrange for inspection of the plants by the Landscape Architect to reserve the plants for this project.

b. All plants are subject to inspection by the Landscape Architect in the nursery or collecting grounds before any are dug. The Landscape Architect shall be the sole judge of the quality and acceptability of the plants.

c. The Contractor shall inspect all plants to determine that they conform to the specifications before he arranges for the Landscape Architect to inspect them. The Contractor shall accompany the Landscape Architect on the inspection trip. The cost of such inspection shall be included in the bid price.

d. If approved by the Landscape Architect, the Contractor may submit photographs of the plants he proposes to furnish in lieu of arranging an inspection trip. Such photographs shall clearly show the character of the plants and shall contain some object, such as a yardstick or person, to indicate the size of the plants. Plants, which the Landscape Architect approves on the basis of photographs, are subject to inspection after they are delivered to the project site.

e. Plants shall be subject to inspection at any stage of the work. The Landscape Architect will reject any plants, which become unacceptable as a result of mishandling, accident, improper maintenance, etc.

D. Other Materials

a. Topsoil shall be clean, friable, loam topsoil, containing no organic matter, brickbats or other debris, or toxic materials. See also Seeding section for additional topsoil requirements. Contractor shall submit sample of topsoil he proposes to use to the Landscape Architect for review. Do not use topsoil until approved by the Landscape Architect.

b. Leaf compost or similar organic matter.

c. Mulch shall be spent licorice root, double-shredded oak bark, or other natural organic material approved by the Landscape Architect. It shall be a uniform material with a fibrous and matting quality, which will have a uniform texture when placed. It shall be dark brown to gray. Submit sample of mulch for approval of Landscape Architect.

d. Crushed stone shall be 1/2" - 3/4" diameter and contain no fines are stones smaller than that specified.

e. Geotextile fabric shall be Mirafi 140NS or equal.

f. Fertilizers:

a) Fertilizer tablets shall be 21 gram Agriform 20-10-5 Planting Tablets as manufactured by Sierra Chemical Company, Milpitas, California, or equivalent approved by the Landscape Architect.

b) Liquid fertilizer shall be 15-30-15 soluble fertilizer such as Miracle Gro manufactured by Stern's Nurseries, Geneva, New York or equivalent approved by Landscape Architect.

c) Staking shall be performed as shown on the drawings. Trees shall not be wrapped!

1.3 EXECUTION

A. Time of Planting - Plant under favorable weather conditions during the seasons specified herein or as such seasons may be modified in the plant list for any of the plants. Start planting when other work on the project has progressed to the stage at which planting can be done. In general, plant during the following seasons, except when the ground is muddy or frozen:

a. Deciduous Plants: When plants are dormant - after the leaves turn color in the fall until new leaves appear in the spring.

b. Evergreen Plants: Spring and Fall Planting Seasons.

c. Upon request by the Contractor and approved by the Landscape Architect planting may be done at unspecified seasons provided that the Contractor furnishes any additional protection and maintenance required related to planting during unspecified seasons.

B. Layout

a. The Contractor shall layout all planting as delineated on plans. If a conflict arises with the existing utilities or features, the contractor shall notify the Landscape Architect immediately so that adjustment of the planting may occur.

C. Tree Pits

a. Prepare tree pits as shown on the drawings. Excavate pit and backfill with tamped, damp sand as noted on the plans and details to bring the tree to proper elevation. Backfill with prepared planting soil mix.

b. The Contractor shall be responsible to dispose the excavated material in a proper place suited for such disposal. The Contractor is not permitted to use excavated pit material as backfill for plantings in any way.

D. Setting and Backfilling Trees

a. Set plants in pits, as shown on the drawing. Do not pull burlap out from under root balls unless directed by the Landscape Architect. Cut bindings from around stems and trunk. Remove surplus burlap and binding.

b. Prepare planting backfill mixture consisting, by volume, of 1 part peat moss and 4 parts clean topsoil. Thoroughly mix backfill mixture before placement.

3. Place backfill mixture around the root ball. Tamp backfill firm to prevent settlement in 8" layers. Water plants thoroughly after each layer. If backfill settles after watering, add more backfill to bring to required grade.

E. Prepare Planter Beds

a. Prepare planter beds by incorporating backfill amendments (peat and fertilizer) into top 12" of existing topsoil, which meets specifications for topsoil, or provide topsoil, which does, at recommended ratio. Small shrubs, bulbs and ground covers can be planted directly in prepared bed. Provide excavation and backfill for large shrubs and trees as directed in Section D for trees. Apply two inches of mulch prior to planting operations.

F. Fertilize Trees

a. Place fertilizer tablets when plant pits are backfilled to within 6-8 inches of the surface. Place tablets evenly around the perimeter of the root ball and 1 to 2 inches from the root ball. Place one 21-gram tablet per 1/2" of trunk caliper.

b. Apply liquid fertilizer to trees in the spring of 2003. Prepare fertilizer liquid at concentration recommended by manufacturer and apply in sufficient quantity to saturate the tree pit and planting bed.

G. Pruning and Repair

a. Prune branches of deciduous trees and remove minor damage resulting from planting operations. Perform additional pruning if and as directed by the Landscape Architect. Trace and treat bark wounds as required.

H. Wrapping, Staking and Guying

a. Wrapping of trees shall not be accepted. Staking and Flagging shall be provided for according to the detail drawings.

I. Mulching

a. Place organic mulch over the tree pit and planter beds to a compacted depth of three (3) inches promptly after planting.

J. Topsoil

a. Provide and install topsoil as necessary for all planting beds and tree pits. Add topsoil below seat wall, as necessary to meet the grades specified on the plans.

1.4 MAINTENANCE

A. Water, weed, cultivate, spray, remove and replace dead plants, reset settled plants to proper grades or upright position and perform other necessary operations as may be required to keep the plants in a live and healthy growing condition.

B. Maintain plants from the time that they are planted until all plants have been accepted. Weed every two- (2) weeks during the growing season.

## 1.5 GUARANTEE AND REPLACEMENT

A. Guarantee all plants to remain alive and healthy for a period of one year after completion and acceptance of all of the planting.

Inspection for Beginning the Guarantee Period:

A. Inspection of the planting work to determine its completion for beginning the guarantee period will be made by the Landscape Architect upon notice requesting such inspection submitted by the Contractor at least 10 days prior to the anticipated date. All plants must be alive, healthy and undamaged; all tree pits must be weeded; and all related work must be finished for the planting work to be considered complete and acceptable.

B. After inspection, the Contractor will be notified by the Landscape Architect of the date of the beginning of the guarantee period, or if there are any deficiencies, of the requirements for beginning the guarantee period.

Final Inspection and Replacements:

A. Inspection of the planting to determine its final acceptance will be made by the Landscape Architect at the conclusion of the guarantee period. No plants will be accepted unless they are alive and healthy.

B. Replace, in accordance with the drawings and specifications, any plants that are dead, or, in the opinion of the Landscape Architect, are in an unhealthy or unsightly condition, except for plants damaged by others.

DIVISION 32 – EXTERIOR IMPROVEMENTS
SECTION 32 92 00 – FINE GRADING AND SEEDING

1.1 SCOPE OF WORK

A. Provide necessary labor, materials, tools, and services to seed all disturbed areas with the specified grass seed mixture, as indicated on the plans, after construction. The Contractor is responsible for disturbed areas created by his construction practices as well as the construction practices associated with other contractors. The Contractor is responsible for grading and compacting of previously graded or backfilled areas that have been disturbed by construction operations.

2.1 RELATED SECTIONS

A. Stormwater

3.1 MATERIALS

A. All materials necessary to complete this work shall adhere to the specifications of PennDOT Publication 408, Section 804 unless otherwise indicated.

B. Grass Seed - grass seed shall be fresh, seed of the latest crop. Seed shall be delivered to the site in the original container, unopened, and shall bear the guaranteed analysis of the vendor. Grass seed shall be mixed in the following proportions and shall conform to the following percentages of purity and germination:
Grass Seed:

| Mixture | % by Weight | % Purity | % Germination |
|---|---|---|---|
| Kentucky Blue Grass | 40% | 98% | 85% |
| Penn Lawn Red Fescue | 30% | 98% | 85% |
| Turf-Type Tall Fescue | 30% | 98% | 90% |

Seed at six (6) pounds per 1000 square feet.

C. Mulch shall be green-dyed and air-dried wood cellulose fibers containing no growth or germination inhibiting substances, in packages not exceeding 100 lbs gross, with net weight shown on the package, and meeting the following requirements:
0-17% Moisture content
98-100% Oven dried organic matter
0-1.5% Ash content
1000% Water holding capacity

D. Topsoil: shall consist of friable loam, reasonably free of subsoils, clay lumps, brush roots, other objectionable vegetation, stones, litter or similar objects larger than two (2) inches in any dimension. Topsoil shall meet the following grading analysis: a minimum of sixty (60) percent passing through a No. 10 sieve, a minimum one hundred (100) percent passing through a two (2) inch sieve. Excavated topsoil from the site shall be utilized for the bed preparation of the seeded areas as long as the above conditions are met.

E. Water - water shall not be available on the project site for use by the Landscape Contractor for seeding and planting operations. Water shall be clean, potable and free from any substances injurious to plant growth.

F. Limestone: Ground limestone shall have a minimum of 85% total carbonates and a minimum of 50% total calcium oxides. At least 90% of it shall be able to pass a No. 20 sieve and at least 50% to pass a no. 100 sieve.

G. Fertilizer: high nitrogen fertilizer applied at rates as recommended by the grass seed supplier. A low nitrogen fertilizer with a 5-10-10 ratio shall be used for the wildflower seeding.

H. Rain Garden Mix– ERNMX-180 – As provided by Ernst Conservation Seeds, 8884 Mercer Pike, Meadville, PA 16335 (800) 873-3321, or approved equal. Seed at 4-10 ounces per 1,000 square feet

I. Amended Rain garden soil mix: 40-60% native topsoil, 40-60% leaf compost

4.1 EXECUTION

A. Schedule of Work: This work shall be undertaken only after all other items are complete and during March 1 through June 1 or October 1 through November 15. Work under this section shall consist of the furnishing of all labor and materials necessary for application of all seeding and mulch. Permanent seeding shall be performed within the specified period of time, and as soon as possible following the application of fertilizer.

B. Examination of Conditions: Examine areas and conditions and report any defects detrimental to this work to the Landscape Architect. Do not proceed until such defects are corrected, as start of work shall be considered an acceptance of conditions.

C. Seeding Bed Preparation:

    a. All disturbed areas (outside the bio-retention areas) are to have sub-grade raked to establish proper grades and in preparation of the seed bed. Supply topsoil over all disturbed/sub-grade areas to a minimum depth of 4” in all areas that require lawn seed.

    b. Install amended rain garden mix to the depths indicated on the bio-retention area details.

    c. After preparation, areas shall be seeded evenly at the rates indicated above.

    d. All seed shall be fresh, clean and of the latest crop. No seed shall be utilized that has a mix date older than nine (9) months.

    e. Install mulch immediately following the installation of all seed materials.

D. Application of Lime and Fertilizer: Lime (Lawn areas only) shall be applied separately and prior to the application of any fertilizer or seed and only on seed beds as prepared above. Apply lime at a rate of 800 lbs/ 1000 SY to topsoil in areas to be seeded with the lawn seed mix only. Do not apply lime within areas that are to be seeded with wildflowers. Blend lime

and fertilizer into top 2 inches minimally by raking, disking or harrowing, or other acceptable method, evenly and uniformly.

E. Fertilizer: Apply 10-20-20 analysis Commercial Fertilizer (dry) at a rate of 192 lbs per 1000 SY. Fertilizer shall be applied uniformly just prior to seeding operations and. after which, the seedbed shall again be properly graded and dressed to a smooth finish.

F. Maintenance of the lawn seeded areas shall be limited to two mowings and one weeding to ensure successful germination of the seed sown prior to acceptance by the owner's representative. The Contractor shall be responsible to reseed any areas which fail to germinate or germinate sparsely as determined by the owner's representative. Reseeding shall be as instructed by the owner's representative. See Furnishing and Placing Topsoil / Soil Supplements Section for preparation of soil bed.

G. Maintenance of seeded areas shall commence immediately after each portion of lawn is completed and shall continue until Provisional Acceptance or for not more than a sixty (60) day period following the completion of seeding operations, whichever period is the lesser.

H. Notwithstanding the above, the Contractor shall be responsible for the mowings from the time the grass attains three (3) inches in height. Grass shall be cut to a height of two (2) inches and never less. All lawns shall receive at least two mowings before acceptance. Any areas requiring re-seeding shall also be subject to two cuttings. In no event shall grass height be permitted above three and one-half (3 1/2) inches.

I. In the event the seeding operations are completed too late in the Spring for adequate germination and grass growth, then maintenance shall continue into the Fall until Provisional Acceptance or not later than June of the following year.

J. Contractor shall repair damaged areas due to circumstances which are beyond Contractor's control, after submitting request for change order and obtaining approval for same.

5.1 INSPECTION AND ACCEPTANCE

A. Landscape Architect shall inspect seeded areas upon written request by the Contractor. Inspection and acceptance of these areas may be requested and granted in part, provided the area coincides with the use area of the facility, substantial in size and reasonably regular in configuration.

B. No seeded areas will be accepted unless, and until, all obligations of the contract are carried out with regard to spreading of topsoil, soil supplements, and seeding, mulching, maintenance and provided that the lawn/wildflower areas shall evidence a healthy and uniform stand of grass/wildflowers regardless of the time period so required.

C. Upon acceptance of the work of seeding the Contractor shall be relieved of further responsibility for care or maintenance of the accepted lawns and meadows.

6.1 GUARANTEE

A. The Contractor shall guarantee all seeded areas for a period of **Eighteen (18) month's** after acceptance of all work as determined by the Landscape Architect. It will be the contractor's responsibility to maintain the seeding areas over the guarantee period, if it is determined that poor germination occurred the contractor will be responsible to replace said area.

DIVISION 33
SECTION 33 11 00 WATER UTILITY DISTRIBUTION PIPING

1.1 SECTION INCLUDES

A. Locate and verify pipe size at water system connections.

B. Provide and install water system pressure pipe, fittings, and appurtenances.

C. Provide and install all water system appurtenances, i.e. post-indicator valve(s), gate valve(s), water meter pit(s), backflow preventer(s), fitting(s), valves(s), etc.

D. Provide and install concrete thrust blocks.

E. Connect new water system to existing service lines.

F. Disinfection and testing of new water line.

1.2 RELATED DOCUMENTS

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

B. Related Sections include the following:
a) Rough Grading, Excavation and Trenching Specification.

1.3 SUBMITTALS

A. In accordance with Section 013300, Submittal Requirements:
a) Submit choice of pipe, fittings, and appurtenances for review prior to ordering.

1.4 REFERENCES

A. Pennsylvania Plumbing Code (CPC), latest edition.

B. Upper Pottsgrove Township and AQUA Water Standard requirements.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Water pipe shall be delivered, handled, and stored in a way that prevents damage to the pipe and the entry of foreign materials into the pipe.

B. Regardless of cause, damaged pipe shall be replaced with new products at the expense of the Contractor.

## PART 2 - PRODUCTS

### 2.1 WATER SERVICE PIPE AND FITTINGS

A. All domestic water 2-inch SDR21 conforms to ASTM D2241 for standard dimension ratios with a pressure tolerance of 200 psi. including gasket joint fittings with a double seal lock

### 2.2 WATER SYSTEM APPURTENANCES

A. All domestic water line valves shall be bronze body ball valves centered in a valve box with a PVC riser.
B. Backflow preventer shall be the model indicated on the plans per the drawing details and the AQUA approved list and standard drawings, or approved equal.
C. Corporation Stop
D. Curb Stop/Gate Valve and Lid
E. Pre-assembled water meter pit, as manufactured by LB Water, or equal
F. Copper Pipe per ASTM B42 Standards Specifications for Copper, including all fittings

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Construction of the private domestic water system shall conform to the requirements of the International Plumbing Code.

### 3.2 POTHOLING AT CONNECTION POINTS

A. The exact location and size of existing water service lines is depicted on the plans based upon the best information provided by AQUA America.

B. The Contractor shall pothole in the vicinity of the connection point to verify the exact location and size of the existing water line. That information shall be presented in the form of a field sketch through the RFI process, for confirmation by the Owners Representative that the line as located is adequate to serve the proposed buildings.

### 3.3 PIPE DISTRIBUTION AND HANDLING

A. Pipe distribution shall not take place too far in advance of laying operations.

B. Pipe shall be handled carefully to avoid damage. Pipe handling by mechanical equipment shall be in accordance with the pipe manufacturer's recommendations.

C. All pipe, fittings, and valves shall be carefully lowered into the trench in such a manner as to prevent damage to pipe materials, protective coatings and linings. Under no circumstances shall pipe materials be dropped or dumped into the trench.

3.4 PIPE LAYING

A. No pipe shall be laid in water or when trench conditions are unsuitable to allow performing the job in a professional manner.

B. Pipe shall be laid with bell ends facing in the direction of laying, and shall progress uphill.

C. Pipe deflections, where permitted, shall not exceed that recommended by the pipe manufacturer.

D. Pipe and fittings which do not allow sufficient space for joints shall be removed and replaced with pipe and fittings of proper dimensions.

E. Every precaution shall be taken to prevent foreign material from entering the pipe. If necessary, 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 adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. If foreign materials do enter the pipe, they shall be removed continuously as work progresses.

F. At times when pipe laying is not in progress, the open ends of laid pipe shall be closed by a watertight plug.

G. Wherever the jointing material specified is cement, two or more lengths of pipe shall be in place ahead of each joint before such joint is finished.

H. Where PVC, SCH 80, pipe is used, pipe ends shall be lightly sanded and wiped just prior to making the joint to assure good adhesion.

3.5 FLUSHING AND TESTING

A. Private Potable Water System
   a) The system shall be flushed with potable water until only potable water appears at the outlet point.
   b) The system shall be disinfected in accordance with Section 609.9 of the International Plumbing Code.
   c) The system shall be hydrostatically tested in accordance with Section 609.4 of the International Plumbing Code.

B. Tests shall be made by the Contractor in the presence of the authority having jurisdiction and the Owner’s Representative.

## 3.6 CONNECTIONS TO EXISTING SERVICES AND MAINS

A. Contractor shall not make connections to existing mains where indicated on the plans. An AQUA America representative shall make the water main connection and set the meter Said connections shall be made after new water pipe is flushed and tested in accordance with this specification. The Owner's Representative and Upper Pottsgrove's Inspector shall observe all tests.

B. Sawcut, remove, and repair existing pavements as noted on plans.

## 3.7 CLEAN UP

A. Remove all debris and stains resulting from the work of this section.

**DIVISION 33 - SITE UTILITIES**
**SECTION 33 30 00 SANITARY SEWER**

1.1 SCOPE OF WORK:

A. The work of this Section consists of providing all required labor, supervision, materials and equipment to satisfactorily complete all sanitary installations that are shown on the Civil Drawings and included in these specifications. Sanitary utilities that are contained within the proposed structures is specifically excluded from these specifications.

1.2 SECTION INCLUDES

A. Installation of sanitary sewage systems work as indicated on the Civil Drawings and Schedules, and by requirements of this Section.

B. The Contractor shall air test pipe sewer lines and vacuum test manholes as specified in this Section. The Contractor shall furnish labor, materials, testing equipment and accessories, and air and water necessary to perform the required tests. Tests shall be made in the presence of and to the complete satisfaction of the Owner's Representative.

1.3 RELATED SECTIONS

| | |
|---|---|
| Section 31 00 00 | Earthwork |
| Section 31 20 00 | Rough Grading, Excavation, and Trenching |

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of sanitary sewage system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installers Qualifications: Firm with at least 3 years of successful installation experience on projects with sanitary sewage work similar to that required for this project.

C. Tester's Qualifications: Firm with at least 3 years of experience in testing sanitary sewers with similar air testing equipment on work of similar scope to this project.

D. Local Plumbing Code Compliance

1.5 SUBMITTALS

A. Submit shop drawings for review before starting work. Shop drawings and product technical data shall also be submitted to the Owner's Representative for review and approval.

B. Product Data: Submit manufacturer's technical product data and installation instructions for sewage system materials and products.

C. Record Documents: At project closeout, submit record drawings of installed sanitary sewage piping

and products, in accordance with the requirements of Division 33.

1.6 REGULATORY REQUIREMENTS

A. Comply with the requirements of Upper Pottsgrove as detailed in their standard construction and material specifications which is incorporated herein by reference.

1.7 MATERIALS (PIPES, PIPE FITTINGS AND APPURTENANCES)

A. Pipe fittings and accessories shall be of same material and weight/class as pipes, with joining method as indicated.

B. Schedule 40 Polyvinyl Chloride (PVC) Pipe

C. Fittings: PE SDR, ASTM D3034, solvent-cement joints complying with ASTM D2855 using solvent cement complying with ASTM D2564; or elastomeric joints complying with ASTM D3212 using elastomeric seals complying with ASTM F477.

D. 2" SDR21 conforms to ASTM D2241 for standard dimension ratios with a pressure tolerance of 200 psi. including gasket joint fittings with a double seal locked

E. Valmatic (or equal) automatic air release valve (small orifice valve).

F. 1500 Gallon Wastewater Storage Tank, including Grade rings and Cast-Iron Lid, H20 Vehicular Rated (truck axle loading of 32,000 lbs, or 16,000 lbs per wheel load).

PART 2 - EXECUTION

2.1 INSTALLATION OF PIPE AND FITTINGS

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. Inspect piping before installation to detect defects. Mark defective materials with white paint and promptly remove from site.

C. Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.

D. Place bell ends or groove ends of piping facing upstream.

E. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements and other special installation requirements.

F. Plastic Pipe: Install in accordance with manufacturer's installation recommendations and in accordance with ASTM D2321 for Class I bedding material, and ASTM D 2855.

G. Cleaning Piping: Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.

H. In large, accessible piping, brushes and brooms may be used for cleaning.

I. Place plugs in ends of uncompleted laterals at end of day or whenever work stops.

J. Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.

K. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects and reinspect.

## 2.2 CLEAN-OUTS/FLUSHING STATIONS

A. Construct clean-outs/flushing stations to grade in accordance with details shown on Contract Drawings.

B. Set clean-out frame and cover in concrete bed and in accordance with manufacturer's recommendations.

TAP CONNECTIONS

A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to requirements specified for new work.

B. Branch connections made from proposed 2" sanitary main to 1-1/4" inch lateral piping shall be made using appropriate material for gasket wye joint fittings with a double seal lock..

C. Install sanitary sewer stub end on the end of the proposed 2" sanitary main for future main extensions.

D. Prevent debris from entering existing piping or structure while making tap connections.

## 2.3 PIPE BEDDING AND TRENCH BACKFILL

A. Classification of Materials

a. Class 1: AASHTO #57 coarse aggregate.
b. Class 3: This material shall consist of excavated material approved by Owner's Representative, containing no stones larger than 4 inches in maximum dimension. A maximum of 20% of the backfill volume may be stones so long as the stones are evenly distributed within the material.

B. Bedding

a. The trench shall be excavated to a depth of 6 inches below the final elevation of the outside bottom of the pipe barrel. Where no existing underground utilities are located, excavation may be done by machine. Where existing underground utilities are indicated, excavation by hand methods shall be used. The subgrade shall be prepared by placing a thoroughly compacted Class 1 material in 3 inches (uncompacted thickness) layers to 12 inches above the pipe crown. Subgrade shall provide uniform and continuous bearing and support for the pipe at

every point between bell holes.

C. Special Bedding

a. Concrete Cradle and Concrete Encasement: The trench shall be excavated to a depth of 6 inches below the final invert elevation of pipes 24 inches in diameter or less, and 9 inches below the final invert elevation of pipes larger than 24 inches in diameter. All of this excavation may be done by machine. Quality of concrete and method of placement is specified elsewhere.

b. Unstable Subgrade: Where the bottom of the trench at subgrade is found to be unstable or to includes ashes, cinders, any type of refuse, vegetable or other organic material, or large pieces or fragments of inorganic material, which, in the opinion of the Owner's Representative should be removed, the Contractor shall excavate and remove such unsuitable material to the width and depth ordered by the Owner's Representative. Before the pipe is laid, the subgrade shall be made by backfilling with Class 1 material in 3-inch (uncompacted thickness) layers. The layers shall be thoroughly tamped and the subgrade prepared as hereinbefore specified.

c. Special Foundations: Where the bottom of the trench at the subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the Owner's Representative, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, the Contractor shall construct a foundation for the pipe, consisting of piling, timbers or other materials, in accordance with plans prepared by the Engineer. Extra compensation will be allowed for the additional work.

d. Excavation in Fill: When the pipe is laid in fill, the compacted embankment shall be brought to a height of at least 9 inches above the proposed top of pipe before the trench is excavated.

D. Backfilling

a. Backfill Materials
    a) General: All backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stone, or other material which in the opinion of the Owner's Representative is unsuitable.
    b) Backfilling shall not be done in freezing weather, except by permission of the v, and it shall not be made with frozen material. No fill shall be made where the material already in the trench is frozen.
    c) Excavated Materials: When the type of backfill material is not indicated on the drawings or specified, the Contractor may backfill with excavated material, provided that such material consists of loam, clay, sand, gravel or other materials which, in the opinion of the Owner's Representative, are suitable for backfilling. Where excavated material is to be used for backfill and there is a deficiency due to a rejection or part thereof, the Contractor shall furnish the required amount of approved material at no additional cost.
    d) Crushed Stone Backfill: Where crushed stone backfill is not indicated on the drawings or specified herein, and in the opinion of the Owner's Representative, should be used in any part of the work, the Contractor shall furnish and backfill with crushed stone as directed.

e) Crushed stone shall consist of the product obtained from crushing sound limestone or dolomite ledge rock and shall be free from excessive amounts of clay and other undesirable materials. All materials shall conform to PennDOT Specification for AASHTO No. 2A or AASHTO #57 coarse aggregate.

f) Backfilling Methods

1) Backfill Beneath and to Twelve Inches (12") Above the Top of Pipe – Class 1 Material: All trenches shall be backfilled by hand, from the bottom of the trench to the centerline of the pipe with Class 1 material, placed in layers of 3 inches (uncompacted thickness), and compacted by tamping. Backfilling material shall be deposited in the trench for its full width on each side of the pipe and fittings simultaneously.
2) Where flexible conduits (Truss, Acrylonitrile-Butadliene-Styrene, Polyvinyl Chloride, Reinforced Plastic Mortar, Ductile Iron, Steel, Corrugated Metal, Polyethylene) are used, the backfill material shall be compacted to a minimum density of 95% Standard Proctor (ASTM D-1557).
3) Backfill to Grade – Class 3 Material: From 12 inches above the top of the pipe to finish subgrade, the trench shall be backfilled by hand or by approved mechanical methods. Backfill in this section of the trench shall be Class 3 material, subject to limitations specified, and consolidated by tamping in 8-inch layers. Where pipe is located under a paved area or roadway, the entire trench shall be backfilled from 12 inches above the top of the pipe to finished subgrade with PennDOT No. 2A coarse aggregate.

## 2.4 GRINDER PUMP INSTALLATION

A. MATERIALS & PRODUCTS:

a. The DH152-129 Grinder Pump as specified by Systems Designs and E-ONE. The station includes: two grinder pumps with check valves, HDPE (high density polyethylene) tank, riser, joints, and controls.
b. Motor: 1 hp, 1,725 rpm, high torque, capacitor start, thermally protected, 120/240V, 60 Hz
c. 1 phase Anti-siphon valve(Noryl)
d. Check Valve (Noryl)
e. Inlet Connections
f. 4-inch inlet grommet standard for SCH40 PVC
g. Pump discharge terminates in 1 1/4-inch NPT female thread.
h. Discharge
    a) 15 gpm at 0 psig (per pump)
    b) 11 gpm at 40 psig (per pump)
    c) 7.8 gpm at 80 psig (per pump)

i. Control Panel (Alarm as specified by Site Specific Design and E-ONE), including circuit breakers, 240 service, terminal blocks and ground lugs, audible alarm with manual

silence, manual run feature and run indicator, safety front, conformal-coated board and overload protection. Trouble indication that shuts down the pumps temporarily in the event of an unacceptable operating condition (brownout, system over-pressure, run-dry), as well as:

a) Predictive status display module
b) Pre-alarm indication for major operating parameters
c) Alarm indications for major operating parameters
d) Hour meter, cycle counter and alarm delay
e) LCD display and user-friendly interface
f) Inner cover (dead front)
g) Contact group — dry contacts and Remote Sentry contactsProgrammable User Settings

## 2.5 WASTEWATER PIT INSTALLATION

A. Install the wastewater pit according to the manufactural installation instructions and detail drawings, MFG instructions taking precedence. The lid of the pit/vault shall be installed flush with the surround proposed asphalt paving

## 2.6 FIELD QUALITY CONTROL

A. After a section of pipe sewer line between cleanouts has been backfilled, a “Line Acceptance Test” using low pressure air shall be performed by the Contractor.

B. The Contractor may elect to make an air test prior to backfilling for his own purposes, but the “Line Acceptance Test” shall be performed on the entire length of the pipe sewer line between adjacent manholes after the backfilling has been completed.

C. Testing Equipment:

a) The low pressure “Line Acceptance Tests” shall be performed by air testing equipment consisting of an air compressor and storage tank of adequate capacity; an air control panel equipped with necessary piping, valves and pressure gages to control the rate at which the air flows to the test section and to monitor the air pressure inside the test section; and required plugs.
b) In order to prevent loading the test section with the full pressure of the compressor, the test equipment shall be provided with an approved pressure relief device, set to blow out at 10 psi. An extra pressure gage of known accuracy must also be provided so that the gages of the test equipment can be frequently checked.
c) The air testing equipment shall be adequate to conduct the required “Line Acceptance Test” and shall be subject to review by the Owner’s Representative. All tests shall be performed in the presence of and to the satisfaction of the Owner’s Representative.

D. Cleaning: Before any “Line Acceptance Test” is performed, pipe lines in the section of the pipe sewer to be tested, including the main and service connection lines, shall be thoroughly cleaned and tested for deflection using a mandrel having a diameter of 95% of the inside diameter of the pipe. In the event cemented or wedged debris, or damaged pipe shall stop the ball, the Contractor shall repair the pipe

and/or remove the obstruction.

E. Test Procedures for "Line Acceptance Test:"

a) After the section of pipe sewer to be tested has been cleaned to the complete satisfaction of the Engineer, the Contractor shall plug all pipe outlets.
b) The ends of branch fittings and service connection piping shall be plugged with plugs properly designed to withstand the test pressures to which they will be subjected. Each plug shall be securely braced after installation. Plugs must remain in place upon satisfactory completion of the test. Plugs shall be obtained from the pipe manufacturer.
c) The ends of the sewer main piping shall be plugged with pneumatic plugs at the upstream and downstream manholes. The pneumatic plugs shall be inflated to 25 psig. The pneumatic plugs shall be seal tested before being used in the actual test installation. To seal test the pneumatic plugs, one length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized without bracing and without movement of the plugs out of the pipe.
d) Immediately after the section of pipe sewer line to be tested has been properly cleaned and sealed, low pressure air shall be slowly introduced into this sealed section of pipe sewer line until the internal air pressure reaches 4 psig greater than the average back pressure of any groundwater that may be over the pipe.
e) After an internal pressure of 4 psig is obtained, allow at least 2 minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure.
f) After the stabilization period (3.5 psig minimum pressure in the pipe), the air supply shall be disconnected, and then the rate of air loss shall be determined by measuring the time interval required for the internal pressure to decrease from 3.5 psig to 2.5 psig greater than the average back pressure of any groundwater that may submerge the pipe.
g) To determine the presence of groundwater, the Contractor shall install a ½ inch diameter capped pipe nipple, approximately 10 inches long, through each manhole wall on top of the sewer main entering the manhole. This shall be done at the time the sewer main piping is installed. Immediately before performing the Acceptance Test, the groundwater shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the pipe nipple. The hose shall be held vertically and a measurement of the height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings (for example, if the height of the water is 11.5 feet, then the added pressure will be 5.0 psig. This increases the 3.5 psig to 8.5 psig, and the 2.5 psig to 7.5 psig. The allowable drop of 1 pound and the timing remain the same.)
h) The section of pipe sewer line being tested shall be considered acceptable when tested at an average pressure of 3.0 psig greater than the average back pressure of any groundwater that may submerge the pipe, if (1) the total rate of air loss from any section tested does not exceed 2.0 cfm, or (2) the section under test does not lose air at a rate greater than 0.0030 cfm per square foot of internal pipe surface.
i) The requirements of this Specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 psig to 2.5 psig greater than the average back pressure of any groundwater that may submerge the pipe is not less than shown for the given diameters in the Air Test Tables.

F. Safety Requirements: The following safety requirements shall be observed by the Contractor in

connection with the air testing of pipe sewer lines.

a) Gages, air piping manifolds and valves of the air testing equipment shall be located above ground at the top of the trench.
b) The plugs used to close the ends of the sewer main piping, branch fittings and service connection piping shall be securely braced in such a way so as to prevent blow outs.
c) Special care shall be exercised during removal of plugs and the pressure in the piping of the test section shall be completely relieved before any plug shall be permitted to be removed.

G. Repair and Test: If any section of pipe sewer line fails to meet these test requirements, the Contractor shall determine the source or sources of leakage. The Contractor shall repair or replace defective material and/or workmanship and shall conduct such additional tests as required to demonstrate that the pipe sewer line meets the test requirements specified.

H. Air Test Tables for Various Pipe Diameters: Minimum holding time in seconds required for pressure to drop from 3.5 psig to 2.5 psig:

| Pipe Diameter (Inches) | Time (Seconds) |
|---|---|
| 1-4 | 175 |
| 6+ | 237 |

DIVISION 33 – UTILITIES
SECTION 33 40 00 – STORMWATER UTILITIES

## 1.1 SCOPE OF WORK

The Contractor shall provide all necessary labor, tools, equipment, and materials necessary to fabricate and install stormwater utilities and all incidentals and appurtenances as shown on the Drawings and/or as specified herein.

## 1.2 MATERIALS

A. Pre-cast, reinforced concrete box 2'x 2' and 2' x4', type "M" inlet top
B. Trench drain
C. Water quality insert (trench drain & inlets)
D. Flared end section
E. Pipe connectors
F. PVC Pipe
G. HDPE pipe
H. Pipe cleanout
I. Storm manhole

## 1.3 SECTION INCLUDES

A. Site storm sewerage drainage piping, fittings and accessories and structures.

## 1.4 RELATED SECTIONS

A. Division 31 Section "Earth Moving": Excavating and backfilling for storm sewer system piping.

## 1.5 REFERENCES

A. AASHTO M 252- High Density Polyethylene Pipe, 4- to 10- Inch Diameter, Type S, with smooth interior lining and watertight joints. Where perforated pipe is specified, Type 2 perforations shall be provided.
B. AASHTO M 294- High Density Polyethylene Pipe, 12- to 36- Inch Diameter, Type S, with smooth interior lining and watertight joints.
C. AASHTO D 1785 – Schedule 40 polyvinyl chloride pipe.
D. PennDOT – Pennsylvania Department of Transportation – Publication 408 Specifications.

## 1.6 SUBMITTALS

A. Submit shop drawings and receive approval before starting work.
B. Product Data: Provide data indicating pipe, pipe accessories, and fittings, inlet and manhole structures and inlet manhole frame, grates and covers.
C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of pipe runs, connections, manholes, inlets and invert elevations.

1.8 FIELD MEASUREMENTS

A. Verify that field measurements and elevations are as indicated on Contract Drawings.

PART 2 - PRODUCTS

2.1 STORM SEWER PIPE MATERIALS

A. High Density Polyethylene Pipe: Conforming to AASHTO M-294, Type S or AASHTO M-252, Type S, with smooth interior lining. Fittings shall be furnished with integral bells. Joints shall be watertight, meeting the requirements of ASTM D3212. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477.

B. C. Polyvinyl Chloride (PVC) Pipe: Conforming to ASTM D 1785 for schedule 40 pipe (0.237 in. minimum wall thickness) with gasketed integral bell joining system.

2.2 PIPE ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, end sections and other configurations required.

B. Filter Fabric: Class 1 Geotextile, meeting the requirements of PennDOT Publication 408, Section 735.

2.3 MISCELLANEOUS MATERIALS

A. Coarse Aggregates meeting the requirements of PennDOT Publication 408, Section 703.2: AASHTO No. 57 coarse aggregate – pipe bedding and structure base, PA DOT No. 2A coarse aggregate for pipe backfill.

B. Riprap - Rock utilized for riprap should consist of sound, durable rock, insoluble in water. Riprap should be free of structural defects, shale seams, and foreign materials such as quarry dust, soil, shale, and organic matter. Individual pieces should be sharply angular, whenever possible, block-shaped and have a minimum specific gravity of 2.5. Where rock is used having average unit weights that vary significantly from 165 lb/ft3 , the size of the individual pieces should be adjusted according to Table 6.8 of the Pennsylvania Erosion and Sediment Pollution Control Manual, March 2012 or latest issue. No piece should have a length exceeding three (3) times its width or depth. Each load should be well-graded from the smallest to the largest stone size. Pieces smaller than the minimum size may not exceed 15% of the tonnage shipped. Minimum placement thickness should be equal to 1.5 times the maximum stone size (dmax).

2.4 STORM DRAINAGE STRUCTURES

A. Precast Reinforced Concrete Inlets and Manholes:

1. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.

2. Joints of the manhole sections shall conform to the requirements of ASTM Specification Designation C443/C361/D1056.
3. Each section of the precast manholes shall have not more than two (2) holes for the purpose of handling and laying. The holes shall be tapered and shall be plugged with rubber stoppers or mortar-finished flush with the wall after installation.
4. Manhole section joints and pipe to manhole joints shall be designed to meeting resilient connector requirements of ASTM C923. Pipe seals shall be "A Lok" or approved equal.

B. Steps
1. Inlets and manholes shall be supplied with steps meeting the requirements of PennDOT Publication 408, Section 605.02(b). The manhole steps shall be built into the wall so as to form a continuous ladder with a maximum distance of twelve (12) inches between steps.

C. Gravel Base:
1. Gravel base for endwalls, flared end sections, inlets and manholes shall be AASHTO No. 57 coarse aggregate, 6 inches thick.

2.5 FRAMES, GRATES AND COVERS

A. All inlet grates and manhole covers shall be heavy duty and shall meet the loading requirements of AASHTO Standard HS-25. Grates shall be bicycle safe type.

B. All castings shall meet the requirements of PennDOT Publication 408, Section 605.2. Inlet frames and grates shall be structural steel with bicycle safety bars meeting the requirements of PennDOT Publication, Section 1105.02(a)2. Manhole frames and covers shall meet the requirements of PennDOT Publication 408, Section 1105.02(h).

C. The Professional reserves the right to reject any and all castings not meetings specifications at any time, either at the shop or on the job site.

D. Materials shall be commercially available products of reputable Manufacturers acceptable to the Professional.

E. Clean-out frame and cover: Catalogue number 1574 as manufactured by East Jordan Works, Inc. (800-626-4653), or approved equal. Castings shall be manufactured from gray iron conforming to ASTM A48 and shall have the word "STORM" cast onto the cover.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut or excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Excavate pipe trench in accordance with the Excavation and Grading Specification, contained herin. Hand trim excavations to required elevations. Correct over excavation with modified granular aggregate. Install bedding material as specified. Notch under pipe bells to provide solid bearing for entire body of pipe.

B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal joints watertight. Install initial pipe backfill material as specified.

B. Connect new pipe to existing inlets and connect existing pipe to new structures where indicated on drawings. Cut pipe flush with inside face of structure and seal annular space between pipe and structure wall with non-shrink, watertight grout.

C. Install polyvinyl chloride pipe and assemble joints in accordance with manufacturer's recommendations.

3.4 TRENCH BACKFILL

A. Backfill trenches using coarse aggregate and suitable materials as specified on the detail drawings.

3.5 FIELD QUALITY CONTROL

A. Field inspection will be performed by the Owner's representative.

B. Request inspection prior to placing cover over pipe.

C. Compaction testing of backfill lifts will be performed by the Owner's representative.

D. The Contractor is responsible for providing Engineering oversight during construction of the stormwater management facilities. A licensed Professional must be present to observe and verify installation and construction of the Post-Construction Stormwater Management Plan at the following critical stages:

1. Completion of the bioretention area and managed release bio-retetion area.
2. Installation of water quality inlet filters

3.6 PROTECTION

A. Protect finished Work.

B. Protect pipe from damage or displacement until backfilling operation is in progress.

3.7 DRAINAGE STRUCTURES

A. Precast Inlet Boxes and Manholes:

1. Base sections shall be installed on a firm stabilized foundation and a six inch (6") bed of AASHTO No. 57 coarse aggregate.
2. The bell of the base should be wiped clean and free of all dirt and grit and liberally soaped in preparation for receiving the riser, cone or slab top sections.
3. Prior to snapping the gasket onto the spigot groove of the riser or cone sections, the gasket should be wiped clean and soaped.
4. The riser or cone section with gasket in place should then be lowered into the bell of the manhole base taking care that no dirt gets into the joint or on the gasket.
5. Additional riser or cone sections should be jointed in a similar manner.
6. Adjustment to indicated elevation, if required, shall be made using precast concrete grade rings. Brick masonry units shall not be used to adjust final grade of inlet and manhole frames.

B. Frame:

1. The frame shall be set in a firm bed of mortar with its top level with the final finished elevation as indicated on the Contract Drawings.

3.8 GRATES AND COVERS

A. When installed, grates and covers shall seat firmly in their frames and shall not rock, rattle or in any other manner move as traffic passes over them.

DIVISION 33 – NATURAL GAS DISTRIBUTION
SECTION 33 51 00 – PROPANE TANKS

SCOPE OF WORK

The Contractor shall provide all labor, materials, and equipment necessary to install the propane gas tanks including all incidentals and appurtenances as shown on the drawings and/or as specified herein.

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASME Section VIII, Division 1 Code

B. Registered with the National Board of Boiler & Pressure Vessels Inspectors

C. Complies with NFPA

1.2 SUBMITTALS

A. Product Data: Provide for each propane storage tank, component, finish, and accessory specified.

1.3 DELIVERY, STORAGE AND HANDLING

A. Protect propane storage tanks and accessories during delivery, storage, and handling.

PART 2 - MATERIALS

2.1 Vessel requirements for underground installation

A. Tanks fully fitted with Reg O valves and Rochester liquid level gauges

B. Container pressure rated at 250 PSI @ 400°F

C. Vacuum purged

D. Duplicate data plate is zip tied on the riser pipe below the anode bolt connection

E. 14” short risers with Short plastic shroud assemblies (w/lid)

F. Anode bolt connection located under the dome

G. #54 liquid level outage valve orifice

H. Dimensions: 8’ 8-1/2” long by 41” O.D. (500g vessel), 15’-11” by 41” O.D. (1,000g vessel)

2.2 Shroud features (500 & 1,000 gallon vessel)

A. Large opening for easy filling and maintenance

B. Recessed markers to indicate proper burial depth

C. Permanent hole for mounting location flag

D. Access on sides for flexible riser connection

E. Shroud dimensions for short riser: 19 3/8” X 26 5/16”

2.3 Paint specifications

A. Epoxy powder paint for maximum rust protection

B. Tanks painted gray

C. Ready to bury durable epoxy powder coating

2.4 Process Control

A. All welded products are x-rayed and pressure tested @ 325 PSI per ASME Sec VIII, Div 1 requirements, followed by rigorous leak test inspections, both pre and post valving

2.5 Other materials

A. Magnesium Anode Bag 7.7KG/17lb 1.7V, INCL 32 ft. of 8 gauge red XLPE/PVC cable, for underground propane tanks and pipes

B. AASHTO #7 stone or course sand

PART 3 - EXECUTION

3.1 EXAMINATION AND INSTALLATION

A. Examine substrates for compliance with manufacturer’s requirements for placement and location of underground vessels, and other conditions affecting installation of bollards.

a. Use coarse sand as bedding and backfill material around the vessel should surrounding soils contain rocks or similar abrasives

b. Use AASHTO #7 stone as bedding and backfill should surrounding soils be free from rocks or similar abrasives.

B. Install vessels according to manufactures specifications, NFPA Standards, directives identified above and the detail drawings.

C. Install (2) magnesium anode bags below the surface of the propane tank according to manufacturer requirements.

D. Do not install damaged, cracked, dented, deformed or marred vessels. Field touch-up minor imperfections in the surface of the tanks in accordance with manufacturer’s instructions.

E. Backfill tanks with a minimum depth of 6 inches above the top surface of in areas of no vehicular traffic. If it's determined that vehicular traffic of any type will traverse above the vessels, a minimum of 24 inches of backfill is required and the installation of tall risers and shrouds should replace the short ones detailed above.