
PROJECT MANUAL

Volume III

ICI WAREHOUSE EXPANSION

Project # 32011091-2026-003

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PROJECT MANUAL

ICI Warehouse Expansion

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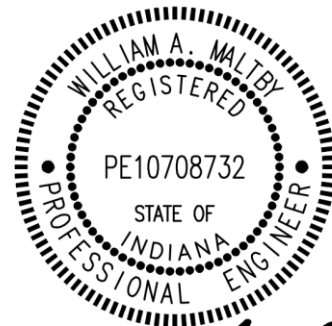
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DIVISION 21

SECTION 21 05 00 - BASIC FIRE-SUPPRESSION MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Drawings, general provisions of the Contract, including General and Supplementary Conditions, and Division-1 Specification Sections and Division 21, 22 and 23 Specification Sections, apply to work of this Section.
- B. This section applies to Division 21, 22 and 23 Specification Sections.
- C. This Section includes limited scope general construction materials and methods for application with fire protection installations as follows:
 - 1. Fire protection equipment nameplate data.
 - 2. Miscellaneous metals for support of mechanical materials and equipment.
 - 3. Joint sealers for sealing around mechanical materials and equipment.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data for the following products:
 - a. Joint sealers.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, supports and anchorage for fire protection materials and equipment.
 - 3. Coordination drawings for access panel and door locations.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer for the installation and application joint sealers, access panels and doors.
- B. Quality welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.5 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect fire protection services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 - 3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
 - 4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
 - 5. Remove existing underground utilities indicated to be removed.
 - a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
 - b. Provide temporary utility services to affected areas. Provide minimum of 14 days notice to Architect and owner prior to utility interruption.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.6 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.
- B. Notify the Architect at least 7 days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated fire protection equipment, provide a permanent operations data nameplate indicating manufacture, project name, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

2.2 SOIL MATERIALS

- A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone or natural or crushed sand.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
- C. Backfill and Fill Materials: Materials complying with ASTM D 2487 soil classification groups GW, and SW; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

2.3 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.4 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacture's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. Acrylic-emulsion sealants: One-part, non-sag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - 2. Fire barrier penetration seals are specified in Section 07 84 00 - Fire Stopping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.3 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned fire protection materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing fire protection materials and equipment indicated to be removed and salvaged and return materials and equipment to the Owner or location designated for storage.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.5 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic- emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contract and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.6 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports with face panels plumb and level in relation to adjacent finished surfaces.
- B. Adjust hardware and panels after installation for proper operation.

END OF SECTION 22 05 00

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

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

2.4 SLEEVE-SEAL FITTINGS

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

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
1. Sleeves are not required for core-drilled holes.

- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
 - 3. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated rough-brass finish.
 - h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - i. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated rough-brass finish.
 - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 21 05 18

SECTION 21 05 29 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal hanger-shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 ACTION SUBMITTALS

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

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

- 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.

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

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

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression 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.
- C. NFPA Compliance: Comply with NFPA 13.
- D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel and stainless steel.

2.3 TRAPEZE PIPE HANGERS

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

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: Zinc-coated or Stainless steel.
 - 2. Outdoor Applications: Stainless steel.

2.5 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.6 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. 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.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

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

3.4 METAL FABRICATIONS

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

3.5 ADJUSTING

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

3.6 PAINTING

- A. Touchup:
 - 1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers 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 thermal hanger-shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS if little or no insulation is required.
 - 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS.
 - 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Comply with NFPA requirements.
- L. Building Attachments: Comply with NFPA requirements. 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. C-Clamps (MSS Type 23): For structural shapes.
 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- M. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinklers.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

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

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. This contractor shall perform fire-hydrant flow test and provide records to indicate the following conditions:
 - a. Date:
 - b. Time:
 - c. Performed by:
 - d. Location of Residual Fire Hydrant R:
 - e. Location of Flow Fire Hydrant F:
 - f. Static Pressure at Residual Fire Hydrant R:
 - g. Measured Flow at Flow Fire Hydrant F:
 - h. Residual Pressure at Residual Fire Hydrant R:

- C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft.
 4. Maximum Protection Area per Sprinkler: Per UL listing.
 5. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: Per NFPA 13 recommendations unless otherwise indicated.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined per NFPA 13 and ASCE/SEI 7.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from all other installers.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

- D. Welding certificates.
- E. Fire-hydrant flow test report.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

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

1.9 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.10 PROJECT CONDITIONS

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

1.11 COORDINATION

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

1.12 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- E. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- F. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- G. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- H. Malleable- or Ductile-Iron Unions: UL 860.
- I. Cast-Iron Flanges: ASME 16.1, Class 125.

- J. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- K. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- L. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts. Fittings in paragraph below are available in NPS 3/4 to NPS 2 (DN 20 to DN 50).
 - 5. Fittings in paragraph below are available in NPS 3/4 to NPS 2 (DN 20 to DN 50).

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

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

2.5 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CECA, LLC.
 - b. Corcoran Piping System Co.
 - c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

C. Flexible, Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc.
 - b. FlexHead Industries, Inc.
 - c. Gateway Tubing, Inc.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.6 SPRINKLERS

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

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Victaulic Company.
5. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

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

D. Sprinkler Finishes:

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

E. Special Coatings:

1. Wax.
2. Lead.
3. Corrosion-resistant paint.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

G. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Fill sprinkler system piping with water.

- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 SPRINKLER INSTALLATION

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

3.5 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

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

3.7 CLEANING

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

3.8 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight or Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 3. Standard-weight or Schedule 40, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 - 4. Standard-weight or Schedule 40, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
 - 5. Standard-weight or Schedule 40, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 6. Standard-weight or Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 7. Standard-weight or Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 8, shall be the following:
 - 1. Standard-weight or Schedule 10, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 10, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 3. Standard-weight or Schedule 10, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Standard-weight or Schedule 10, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 5. Standard-weight or Schedule 10, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.9 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Sidewall, dry sprinklers
5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted cover plate to match the adjacent surface.
2. Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

DIVISION 22

SECTION 22 05 00 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Drawings, general provisions of the Contract, including General and Supplementary Conditions, and Division-1 Specification Sections and Division 21, 22 and 23 Specification Sections, apply to work of this Section.
- B. This section applies to Division 21, 22 and 23 Specification Sections.
- C. This Section includes limited scope general construction materials and methods for application with plumbing installations as follows:
 - 1. Plumbing equipment nameplate data.
 - 2. Excavation for underground utilities and services, including underground piping (under the building and from building to utility connection).
 - 3. Miscellaneous metals for support of plumbing materials and equipment.
 - 4. Joint sealers for sealing around plumbing materials and equipment.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data for the following products:
 - a. Joint sealers.
 - b. Access doors.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
 - 3. Coordination drawings for access panel and door locations.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer for the installation and application joint sealers, access panels and doors.
- B. Quality welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
- C. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.5 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 - 3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
 - 4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
 - 5. Remove existing underground utilities indicated to be removed.
 - a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
 - b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Architect and owner prior to utility interruption.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.6 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.
- B. Notify the Architect at least 5 days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

2.1 PLUMBING EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated plumbing equipment, provide a permanent operations data nameplate indicating manufacture, project name, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

2.2 SOIL MATERIALS

- A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
- C. Backfill and Fill Materials: Materials complying with ASTM D 2487 soil classification groups GW, GP, GM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

2.3 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.4 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacture's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. Acrylic-emulsion sealants: One-part, non-sag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - 2. Fire barrier penetration seals are specified in Section 07 84 00 - Fire Stopping.
- D. Access Doors and Frames:
 - 1. Flush, un-insulated, fire rated and non-fire rated access doors and frames with exposed trim: Fabricated from metallic-coated steel sheet. Joints and seams shall be continuously welded steel with welds ground smooth and flush with adjacent surfaces
 - 2. Frames:
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling wall surfaces, 1" wide exposed perimeter flange and adjustable masonry anchors.
 - b. For installation in gypsum wallboard or plaster wall surfaces, perforated flanges with wall board bead.
 - c. For full bed plaster applications, galvanized expanded metal lath and exposed casing bead welded to the perimeter of the frame.
 - d. For installation in gypsum wallboard ceilings, flush access panels and trimless frames.
 - e. Fire-Resistance Rating: Provide rating same as wall or ceiling for which access door is indicated on drawings.
 - 3. Doors:
 - a. Door: Minimum 0.060-inch-thick sheet metal, flush construction with concealed spring hinges or continuous piano hinge set to open 175 degrees, factory prime painted.
 - b. Fire Rated Doors: Insulated flush panel doors with continuous piano hinge and self-closing mechanism.
 - c. Latch: Self-latching bolt operated by flush key with interior release.
 - d. Prepared to receive mortise cylinder lock, specified in Division 8 Section "Door Hardware," with interior release.
 - e. Flush, screwdriver-operated cam locks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and

application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.3 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 EXCAVATION

- A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
- B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- C. Install sediment and erosion control measures in accordance with local codes and ordinances.
- D. Dewatering: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.
 - 1. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
- F. Trenching: Excavate trenches for plumbing installations as follows:
 - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
 3. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.
 4. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.
 - a. For pipes or equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom 1/4 of the circumference. Fill unevenness with tamped sand backfill. At each pipe joint over-excavate to relieve the bell or pipe joint of the pipe of loads, and to ensure continuous bearing of the pipe barrel on the bearing surface.
- G. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (1 deg 2 C).
- H. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of sub base materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of piping, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
- I. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- J. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- K. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- L. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- M. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesion-less soils).
 - a. Areas under structure, building slabs, steps and pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesion-less material.
 - b. Areas under walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesion-less material.
 - N. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
 - O. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.
- 3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE
- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
 - B. Field Welding: Comply with AWS "Structural Welding Code."
- 3.6 APPLICATION OF JOINT SEALERS
- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 2. Comply with recommendations of ASTM C 790 for use of acrylic- emulsion joint sealants.
 - B. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contract and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
 - C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall

assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.7 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports with face panels plumb and level in relation to adjacent finished surfaces.
- B. Adjust hardware and panels after installation for proper operation.

END OF SECTION 22 05 00

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- F. Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- H. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

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

2.4 SLEEVE-SEAL FITTINGS

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

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
1. Sleeves are not required for core-drilled holes.

- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

- a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
5. Interior Partitions:
- a. Piping Smaller Than NPS 6: Galvanized-Steel-Sheet Sleeves or Steel-Sheet Sleeves
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

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

- B. Related Sections:

1. Division 22 Section "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

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

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

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

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1 ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.3 PRESSURE GAGES

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

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Ashcroft Inc.
 - b. Terice, H. O. Co.
 - c. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Liquid-filled, sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

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

2.5 TEST PLUGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Ashcroft, Inc.
 2. Trerice, H. O. Co.
 3. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Ashcroft, Inc.
 2. Trerice, H. O. Co.
 3. Weiss Instruments, Inc.
- B. Furnish one test-plug kit containing one thermometer, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

- C. High-Range Thermometer: Small, bimetallic insertion type with 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install remote-mounted pressure gages on panel.
- H. Install valve and snubber in piping for each pressure gage for fluids.
- I. Install test plugs in piping tees.
- J. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Outlet of each thermostatic mixing valve.
- K. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each thermostatic mixing valve.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCALE-RANGE SCHEDULE

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

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 100 psi.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Bronze ball valves.
 - 2. Bronze lift check valves.
 - 3. Bronze swing check valves.
 - 4. Bronze gate valves.
 - 5. Bronze globe valves.

- B. Related Sections:

- 1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
 - 2. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61-Annex G for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 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. Handwheel: For valves other than quarter-turn types.
 - 2. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
 - 3. 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. 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. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.
- H. Potable-water valves and components shall comply with NSF-14 and NSF-61.

2.2 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

2.3 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. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, 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.

2.4 BRONZE LIFT CHECK VALVES

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

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, Inc.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
 - e. Red-White Valve Corporation.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

B. Class 125, Lift Check Valves with Nonmetallic Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: NBR, PTFE, or TFE.

2.5 BRONZE SWING CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
2. 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.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).

- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Composition.
 - g. Seat Ring: Bronze.
 - h. Disc Holder: Bronze.
 - i. Disc: PTFE or TFE.
 - j. Gasket: Asbestos free.

2.7 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint]
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

2.8 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO, Inc.
 - e.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded solder joint.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

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 or gate valves.
 - 2. Throttling Service: Globe valves.
 - 3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
 - 4. Mixing valves check valves
 - a. Provide swing type check valve on piping upstream of mixing valves, with pipes in horizontal positions.
 - b. Provide Center-Guided check valves on piping upstream of mixing valves, with pipes in the vertical position.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:

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

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 4 and Smaller:

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

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

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

- B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

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 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Fiberglass strut systems.
 4. Pipe stands.
 5. Equipment supports.
- C. 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 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

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

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 stainless steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Perforated straps are not acceptable.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.5 PIPE POSITIONING SYSTEMS

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

2.6 EQUIPMENT SUPPORTS

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

2.7 MISCELLANEOUS MATERIALS

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

3.2 EQUIPMENT SUPPORTS

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

3.3 METAL FABRICATIONS

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

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09,
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper 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.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, non-stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.

- b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use 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 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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, 1/16 inch thick and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to 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 high.

2.4 VALVE TAGS

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

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches, approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 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. Piping Color-Coding: Painting of piping is specified in Division 09.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near 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 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label:
 - 1. Pipe label color shall be industry standard, ANSE/ASME for all pipe systems.

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.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. All piped systems: 1-1/2 inches.

2. Valve-Tag Color:
 - a. All piped systems: Natural.
3. Letter Color:
 - a. All piped systems: Black.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Recirculated hot-water piping.
 - 4. Stormwater piping.
 - 5. Roof drain bodies.
 - 6. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Block Insulation: ASTM C 552, Type I.
 2. Special-Shaped Insulation: ASTM C 552, Type III.
 3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 4. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 5. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- H. Mineral-Fiber: Preformed pipe insulation of glass fibers bonded with thermosetting resin. Comply with ASTM C547.
1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
 2. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4 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, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGuire Manufacturing.
 - b. Truebro; a brand of IPS Corporation.
 - c. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
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 insulation shields

1. Description: metal shield formed to a 180 degree arc, designed to protect pipe insulation from damage and crushing at hanger locations. saddles shall be constructed from 20 gauge steel.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

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

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install all insulation, continuous through all pipe hangers, provide metal saddle shields to protect from insulation compression at pipe hangers.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. 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. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.**D. Install removable insulation covers at locations indicated. Installation shall conform to the following:**

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe

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

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install 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 cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturers' 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 manufacturers' 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.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturers' recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

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

3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 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.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 3/4 inches thick.
 - b. Flexible Elastomeric: 3/4 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 3/4 inches thick.
 - b. Flexible Elastomeric: 3/4" inches thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1 inch thick.
 - b. Flexible Elastomeric: 1 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1-1/2 inch thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 3/4 inches thick.
 - b. Flexible Elastomeric: 3/4 inches thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 3/4 inches thick.
 - b. Flexible Elastomeric: 3/4 inches thick.

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

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3/4 inch thick.

END OF SECTION 22 07 19

SECTION 22 11 16 - 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, and fittings inside buildings.
 - 2. Encasement for piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

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

- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Products Corporation.
 - b. NIBCO Inc.
 - c. Viega.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, non-metallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet.
- C. Color: Blue.

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.
 - 1. Description:
 - a. One end with threaded brass insert and one solvent-cement-socket end.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International.
 - b. Watts; a division of Watts Water Technologies, Inc.
 - c. Wilkins; a Zurn company.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.

- d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
- 2. Standard: IAPMO PS 66.
 - 3. Electroplated steel nipple complying with ASTM F 1545.
 - 4. Pressure Rating and Temperature: 300 psig at 225 deg F.
 - 5. End Connections: Male threaded or grooved.
 - 6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- D. Install reduced pressure backflow preventers at an elevation of NO greater than 4'-0" above finished floor to the center line of the backflow preventer.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Division 22 Section "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install domestic water piping level without pitch and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."
- R. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section "Meters and Gages for Plumbing Piping."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in 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.
 - 1. Press fittings: DO NOT USE ABRASIVE CLEANING METHODS.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
 1. Vertical Piping: MSS Type 8 or 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet (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.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in Division 22 plumbing fixture Sections.
 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.7 IDENTIFICATION

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

- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

- 1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- 2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

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

- C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

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

3.10 CLEANING

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

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (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. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

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

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) joints.
- E. Above Ground Domestic Water Piping, NPS 2 and smaller 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.
 - 2. Drawn-temper copper tube, ASTM B88M, Type L (ASTM B88M, Type B) copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B88, Type L (ASTM B 88M, Type B) cast or wrought copper, brazed joint fittings.
- F. Above Ground Domestic Water Piping, NPS 2-1/2" and larger shall be the following:
 - 1. Hard Copper tube, ASTM B88, Type L (ASTM B 88M, Type B) cast or wrought copper, brazed joint fittings.
 - 2. Drawn-temper copper tube, ASTM B88M, Type L (ASTM B88M, Type B) copper pressure-seal-joint fittings; and pressure-sealed joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - 2. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Temperature-actuated, water mixing valves.
2. Strainers for domestic water piping.
3. Wall hydrants.
4. Roof hydrants.
5. Drain valves.
6. Water-hammer arresters.
7. Flexible connectors.

- B. Related Requirements:

1. Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.

1.3 DEFINITIONS

- A. AMI: Advanced Metering Infrastructure.
- B. AMR: Automatic Meter Reading.
- C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 DOMESTIC WATER SYSTEM SPECIALTIES

- A. All specialties provided in the domestic water system shall be NSF G1 compliance for low lead.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

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

2.3 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Primary, Thermostatic, Water Mixing Valves:
 - 1. Standard: ASSE 1017.
 - 2. Pressure Rating: 125 psig minimum unless otherwise indicated.
 - 3. Type: Eposed-mounted , thermostatically controlled, water mixing valve.
 - 4. Material: Bronze body with corrosion-resistant interior components.
 - 5. Connections: Threaded or union inlets and outlet.
 - 6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - 7. Cabinet: Factory fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless steel door.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inches.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch .
6. Drain: Pipe plug.

2.5 WALL HYDRANTS

A. Non-Freeze Wall Hydrants :

1. Standard: ASME A112.21.3M for [concealed] [exposed]-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4.
6. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Rough bronze .
9. Outlet, Exposed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Chrome plated .
11. Operating Keys(s): One with each wall hydrant.

2.6 ROOF HYDRANTS

A. Nonfreeze, Draining-Type Roof Hydrants:

1. Standard: ASME A112.21.3M.
2. Type: Non-freeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.
3. Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
4. Inlet: NPS 3/4 .
5. Outlet: Garden-hose thread complying with ASME B1.20.7.
6. Vacuum Breaker:

- a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
- b. Garden-hose thread complying with ASME B1.20.7 on outlet.
- c. Pipe drain fitting to nearest floor drain or mop basin, not within public or private finished spaces.

2.7 DRAIN VALVES

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

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

2.8 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters :

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows or Piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.9 FLEXIBLE CONNECTORS

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

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

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- B. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.

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

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

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

3.5 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Temperature-actuated, water mixing valves.
 - 2. Wall hydrants.
 - 3. Roof hydrants.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

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

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

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 22 11 19

SECTION 22 13 16 - SANITARY WASTE AND VENT AND STORM 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.
 - 3. Encasement for underground metal piping.

- B. Related Sections:

- 1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

- 1. Storm, Soil, Waste, and Vent Piping: 10-foot head of water.

- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Storm, Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager or Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Construction Manager's or 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 (MAY BE UTILIZED IN UNDERSLAB INSTALLATIONS OF SANITARY WASTE.

- A. Pipe and Fittings: ASTM A 74, service and Extra Heavy classes.
- 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 (SHALL BE UTILIZED IN ALL ABOVE CEILING INSTALLATIONS, DUE TO PLENUM RETURN HVAC SYSTEMS)

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Solvent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
- C. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and CISPI 310.

2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - D. Heavy-Duty, Hubless-Piping Couplings:
 1. Standards: ASTM C 1277 and ASTM C 1540.
 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - E. Cast-Iron, Hubless-Piping Couplings:
 1. Standard: ASTM C 1277.
 2. 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 PVC PIPE AND FITTINGS (MAY ONLY BE UTILIZED IN UNDERGROUND AND NON-PLENUM RATED INSTALLATIONS)
- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - C. Adhesive Primer: ASTM F 656.
 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - D. Solvent Cement: ASTM D 2564.
 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 2.5 SPECIALTY PIPE FITTINGS
- A. Transition Couplings:
 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Nonpressure Transition Couplings:

- a. Standard: ASTM C 1173.
- b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
- c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

- a. Standard: ASTM C 1460.
- b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

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

2. Dielectric Unions:

- a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

- a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

- a. Description:
 - 1) Non-conducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: [150 psig (1035 kPa)] <Insert pressure>.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Description:

- 1) Standard: IAPMO PS 66
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

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. All piping located in ceiling plenums shall be metallic or cast iron pipe with no exception.
- B. All vertical piping, if concealed within a column wrap may be installed with PVC pipe and fittings or with metallic or cast iron pipe materials. If the column wrap is not continuous from floor structure to floor structure the entire pipe shall be metallic or cast iron product.
- C. Branch pipe from Storm, sanitary stack and vent stacks shall transition within the column enclosure to a metallic or cast iron product with the use of manufactures approved fittings within the column enclosure. The penetration through the column enclosure shall be fire stopped as required by the building construction type and associated requirements.
- D. 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.
- E. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- H. Install piping to permit valve servicing.
- I. Install piping at indicated slopes.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.

- L. Install piping to allow application of insulation.
- M. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- N. Make changes in direction for storm, 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.
- O. 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.
- P. Install storm, soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- Q. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- R. Install aboveground PVC piping according to ASTM D 2665.
- S. Install underground PVC piping according to ASTM D 2321.
- T. 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. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- U. 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."

- V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."
- Z. All horizontal sanitary pipe shall be insulated.
- AA. All horizontal storm pipe shall be insulated.

3.3 JOINT CONSTRUCTION

- A. 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.
- B. 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.
- C. 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.
- D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, non-pressure transition couplings.

B. Dielectric Fittings:

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

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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

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

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

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

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

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

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

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

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.

2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

- I. Install supports for vertical ABS and PVC piping every 48 inches.
- J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm piping to exterior storm piping. Use transition fitting to join dissimilar piping materials.
- D. Connect drainage and vent piping to the following:
 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
 6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

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

3.10 PIPING SCHEDULE

- A. All piping located in ceiling plenums shall be metallic or cast iron pipe with no exception.
- B. All vertical piping, if concealed within a column wrap may be installed with PVC pipe and fittings or with metallic or cast iron pipe materials. If the column wrap is not continuous from floor structure to floor structure the entire pipe shall be metallic or cast iron product.
- C. Branch pipe from sanitary stack and vent stacks shall transition within the column enclosure to a metallic or cast iron product with the use of manufactures approved fittings within the column enclosure. The penetration through the column enclosure shall be fire stopped as required by the building construction type and associated requirements.
- D. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- E. Aboveground, soil and waste piping NPS 3 and smaller shall be any of the following, as allowed by local code:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI (for buildings three stories and shorter) and heavy-duty (the lower floors below the top three floors of a building four stories or taller) hubless-piping couplings; and coupled joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cement joints.
 - 4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
 - 5. All piping within the return air plenum shall meet the 25/50 flame/smoke rating and shall be metallic or cast iron pipe product rating and shall be metallic or cast iron pipe product.
- F. Aboveground, storm, soil and waste piping NPS 4 and larger shall be any of the following as allowed by local code:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI (for buildings three stories and shorter) and heavy-duty (the lower floors below the top three floors of a building four stories or taller) hubless-piping couplings; and coupled joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cement joints.
 - 4. All piping within the return air plenum shall meet the 25/50 flame/smoke rating and shall be metallic or cast iron pipe product rating and shall be metallic or cast iron pipe product.
 - 5. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- G. Aboveground, vent piping NPS 4 and smaller shall be any of the following as allowed by local code:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cement joints. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.
 - 4. All piping within the return air plenum shall meet the 25/50 flame/smoke rating and shall be metallic or cast iron pipe product rating and shall be metallic or cast iron pipe product.

- H. Aboveground, vent piping NPS 5 and larger shall be any of the following, as allowed by local code:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.
 4. All piping within the return air plenum shall meet the 25/50 flame/smoke rating and shall be metallic or cast iron pipe product rating and shall be metallic or cast iron pipe product.
- I. Underground, storm, soil, waste, and vent piping NPS 4 and smaller shall be any of the following as allowed by local code:
1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- J. Underground, storm, soil and waste piping NPS 5 and larger shall be any of the following as allowed by local code:
1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Cleanouts.
 - 2. Floor drains.

- B. Related Requirements:

- 1. Division 22 Section "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
 - 2. Division 33 Section "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

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

1.8 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 size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.

- f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Josam Company; Blucher-Josam Div.
 - 2. Standard: ASME A112.36.2M for cast iron OR ASME A112.3.1 for stainless steel for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-less, cast-iron soil pipe test tee or Stainless-steel tee with side cleanout as required to match connected piping.
 - 5. Closure: Countersunk, cast-iron plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
 - h. Josam Company; Josam Div.
 - i. Josam Company; Blucher-Josam Div.
 - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Adjustable housing.
 - 5. Body or Ferrule: Cast iron or Stainless steel.
 - 6. Clamping Device: Not required.
 - 7. Outlet Connection: Inside calk.
 - 8. Closure: Brass plug with straight threads and gasket.
 - 9. Adjustable Housing Material: Cast iron with threads.
 - 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or Stainless steel.
 - 11. Frame and Cover Shape: Round.
 - 12. Top Loading Classification: Heavy duty.
 - 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 14. Standard: ASME A112.3.1.
 - 15. Size: Same as connected branch.
 - 16. Housing: Stainless steel.
 - 17. Closure: Stainless steel with seal.
 - 18. Riser: Stainless-steel drainage pipe fitting to cleanout.
- C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-less, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Top Loading Classification: Heavy Duty.

B. Stainless-Steel Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Blucher-Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.3.1, ASME A112.6.3.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- F. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- H. Install vent caps on each vent pipe passing through roof.
- I. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- J. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- K. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

- L. Install wood-blocking reinforcement for wall-mounting-type specialties.
- M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment 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 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 16 14 - NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.
- D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch per foot.
 - 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.6 INFORMATIONAL SUBMITTALS

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

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For motorized gas valves pressure regulators and to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

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

- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING

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

1.10 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Construction Manager's and Owner's written permission.

1.11 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
6. Mechanical Couplings:
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steel bolts, washers, and nuts.
 - d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 1. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 2. Corrugated stainless-steel tubing with polymer coating.
 3. Operating-Pressure Rating: 0.5 psig.
 4. End Fittings: Zinc-coated steel.
 5. Threaded Ends: Comply with ASME B1.20.1.
 6. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 1. Copper-alloy convenience outlet and matching plug connector.
 2. Nitrile seals.
 3. Hand operated with automatic shutoff when disconnected.
 4. For indoor or outdoor applications.
 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

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

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated brass.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE; blowout proof.
 5. Packing: Separate packnut with adjustable-stem packing threaded ends.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated bronze.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE; blowout proof.
 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated bronze.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE.
 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig (4140 kPa).
 8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Bronze Plug Valves: MSS SP-78.

1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig (862 kPa).
6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

J. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 PRESSURE REGULATORS

A. General Requirements:

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

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

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

a. Vent to exterior of building per manufactures requirements

11. Maximum Inlet Pressure: 10 psig.

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

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

2.6 DIELECTRIC FITTINGS

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

B. Dielectric Unions:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: 125 psig minimum at 180 deg F.
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: 150 psig.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

2.7 LABELING AND IDENTIFYING

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54, the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- C. Install fittings for changes in direction and branch connections.
- D. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54, the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.

- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install earthquake valves aboveground outside buildings according to listing.
- D. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

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

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel flat.
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex flat.
 - d. Color: Gray.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd flat.
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54, the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 DEMONSTRATION

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

3.13 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- B. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

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

END OF SECTION 22 16 14

SECTION 22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

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

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. PVI Industries, LLC.

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

2.2 DOMESTIC WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:
 - a. AMTROL Inc.
 - b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - c. Xylem.
- 2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

3. Construction:

- a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
- b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics:

- a. Working-Pressure Rating: 150 psig.

- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- F. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- G. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- H. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base within a drain pan. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."
1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 2. Maintain manufacturer's recommended clearances.
 3. Arrange units so controls and devices that require servicing are accessible.
 4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 6. Install anchor bolts to elevations required for proper attachment to supported equipment.
 7. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."
- E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- F. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- G. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill electric, domestic-water heaters with water.
- I. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters.

END OF SECTION 22 33 00

SECTION 22 46 00 - SECURITY 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. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Supports.

1.3 DEFINITIONS

- A. Accessible Service Space: Service area in secure space behind wall-mounted fixtures.
- B. Back-Access Fixture: Security plumbing fixture designed to mount on wall sleeve built into wall or on wall, so installation and removal of fixture, piping, and other components are accessible only from service space behind wall.
- C. Front-Access Fixture: Security plumbing fixture designed to mount on wall with installation and removal from fixture side of wall, and with piping and other components accessible only from access panel in fixture.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for security plumbing fixtures.
 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For security plumbing fixtures and components to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of quantity of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 STAINLESS-STEEL WATER CLOSETS

- A. Water Closets: Back access, on floor, back outlet, extended bowl.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Willoughby Industries, Inc.
 - b. Acorn Engineering Co.
 - c. Bradley Corp.
 - d. Whitehall Manufacturing.
 - 2. Standard: IAPMO PS 61.
 - 3. Material: 0.078-inch- minimum-thick stainless steel; corrosion-resistant metal for internal piping and bracing.
 - 4. Finish: ASTM A480/A480M, No. 4 polished finish on exposed surfaces.
 - 5. Bowl:
 - a. Type: Elongated, with back inlet, integral trap, and blowout design with back outlet and contoured seat.
 - b. Back-Outlet Connection: NPS 4 (DN 100), horizontal with cleanout and slip joint.
 - c. Seat Surface: ASTM A480/A480M, No. 7 polished finish.
 - 6. Mounting: Bolts through wall sleeve into accessible pipe space.
 - 7. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture. Include steel bars or other design to prevent escape if fixture is removed.
 - a. Configuration: Modify wall sleeve for water-closet mounting height according to ICC A117.1.

2.2 FLUSHOMETER VALVES

- A. Flushometer Valves: Lever handle, diaphragm.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Willoughby Industries, Inc.
 - b. Acorn Engineering Co.
 - c. Bradley Corp.

- d. Whitehall Manufacturing.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig.
- 4. Features: Integral check stops and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Style: Exposed.
- 8. Consumption: 1.6 gal. per flush.
- 9. Minimum Inlet: NPS 1.
- 10. Minimum Outlet: NPS 1-1/4.

2.3 URINALS

A. Urinals: Back access, back outlet, single.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Willoughby Industries, Inc.
 - b. Acorn Engineering Co.
 - c. Bradley Corp.
 - d. Whitehall Manufacturing.
- 2. Fixture:
 - a. Standard: IAPMO PS 61.
 - b. Material: 0.078-inch- minimum-thick stainless steel; corrosion-resistant metal for internal piping and bracing.
 - c. Finish: ASTM A480/A480M, No. 4 polished finish on exposed surfaces.
 - d. Type and Configuration: Washout, with top inlet.
 - e. Drain: Strainer with NPS 2 tailpiece and trap.
- 3. Mounting: Bolts through wall sleeve into accessible service space.
- 4. Flushometer Valve: Exposed.
- 5. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

2.4 STAINLESS-STEEL LAVATORIES

A. Lavatories: Back access.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Willoughby Industries, Inc.
 - b. Acorn Engineering Co.
 - c. Bradley Corp.
 - d. Whitehall Manufacturing.
- 2. Fixture:

- a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Material: 0.078-inch- minimum-thick stainless steel; corrosion-resistant metal for internal piping and bracing.
 - c. Finish: ASTM A480/A480M, No. 4 polished finish on exposed surfaces.
 - d. Receptor: Oval bowl with integral soap depression and backsplash.
 - e. Hot- and Cold-Water and Bubbler Supply Valves: Mechanical-metering type with push-button actuation, individual check stops, and backsplash-mounted filler spouts complying with ASME A112.18.1/CSA B125.1.
 - f. Drain: Integral punched grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2/CSA B125.2.
3. Mounting: Bolts through wall into accessible service space.

2.5 SUPPORTS

A. Water Closet Carrier:

1. Standard: ASME A112.6.1M.
2. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware match fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Type III Lavatory Carrier:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install security plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install back-access, stainless-steel fixtures as follows:
 1. Install wall sleeve in wall if indicated.
 2. Install fixture on wall sleeve or wall, as indicated, with access from accessible service space.
 3. Extend supply piping from service space to fixture.
 4. Install soil and waste piping from fixture and extend into service space.
 5. Install fixture trap in service space instead of below fixture drain.

- C. Install front-access, stainless-steel fixtures as follows:
 - 1. Install fixture support or mounting bracket.
 - 2. Install fixture on support; mount components inside of or attached to fixture.
 - 3. Extend supply piping from pipe space to fixture.
 - 4. Install trap below fixture and extend soil and waste piping into pipe space.
- D. Install fixture outlets with gasket seals.
- E. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.
- F. Seal joints between fixtures, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
- C. Comply with requirements for soil and waste drainage piping specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust flushometer valves and flow-control valves on fixtures.

3.5 CLEANING AND PROTECTION

- A. After installing fixtures, inspect and repair damaged finishes.
- B. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 46 00

SECTION 23 00 00 - HVAC GENERAL REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the general requirements applicable to all Heating, Ventilation, and Air Conditioning work.
- B. Provide complete and fully operational HVAC systems controlled as indicated in the construction documentation.
- C. The construction documents are comprised of both specifications and construction drawings. Information pertinent to design intent may be included in either or both locations, which create one set of contract documents.

1.2 DEFINITIONS

- A. Basis of Design: Equipment and materials identified in the drawing schedules, notes, and specifications and identified as a specific product or example represents the intended Basis of Design. Any equipment or materials provided by the Contractor must meet or exceed the performance quality of the Basis of Design.
- B. Substitution: Any equipment or material which is not the Basis of Design.
- C. General Requirements: The provisions set forth in the Division 01 sections apply to the entire work of the contract and other elements which are included in the project. Basic contract definitions are in the General Conditions.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels generally considered normally occupiable by people.
- E. Exposed, Interior Installations: Installed indoors and exposed to viewing by people. Examples included finished spaces and mechanical rooms equipment rooms.
- F. Exposed, Exterior Installations: Exposed to view but outside the building envelope and therefore exposed to weather and ambient conditions. Examples include roof top locations.
- G. Concealed, Interior Installations: Installed within the building envelope, but concealed from view. Examples include those items installed within walls, above ceilings, below floors, or in chases.
- H. Concealed, Exterior Installations: Installed outside of the building envelope, but concealed from view and protected from weather conditions by a secondary structure, but subject to outdoor ambient conditions. Examples include installations within enclosures that are not heated or cooled.

- I. Indicated: Implication of a cross reference to a graphic representation, note, schedules, or other specification section or another area within the contract documents. The terms “shown”, “noted”, “scheduled”, and “specified” are used as synonyms to “indicated”. No limitation of cross reference location is intended except as specifically noted.
- J. Furnish: Supply and deliver to project site, ready for unloading, unpacking, assembly, installation and similar operations. Where “furnish” applies to work for which the installation is not otherwise specified, “furnish” shall mean “furnish and install”.
- K. Install: Operations at the project site including “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operation.
- L. Provide: To furnish and install complete and ready for intended use.

1.3 SUBMITTALS

- A. Action Submittals: These submittals are required to be returned with no exceptions prior to procuring or installing products or materials. The Submittal Review process is described in Section 01.
 - 1. Work Plans: Written Narrative of the work plan used to create the schedule. Coordinate with other trades and contractors to develop required work plans as required to develop the long term coordinated construction schedule.
 - 2. Product Data: Providing information on the actual product selection intended for use as specified in other Division 23 Specifications and the Construction Documents. All product data submittals shall clearly identify the product to be used subject to rejection.
 - 3. Shop Drawings: Providing information on the actual installation methodology to be used to install items as specified in other Division 23 Specifications and the Construction Documents
- B. Informational Submittals: These submittals are intended to facilitate coordination and construction phasing and scheduling. These submittals will not be returned unless non-conformance with the contract documents is noted.
 - 1. Construction Schedules: Schedule of work showing percent completion of milestones in the work plan. Coordinate with the general contractor, owner, or owner’s representative, to develop, maintain, and regularly update the construction schedule as required
 - 2. Coordination Documents: Drawings including Plans, Sections, Elevations, localized infrastructure crossing details, drawn to scale, on which the items below have been included utilizing information from all trades, contractors, and installers:
 - a. Building Structure and structural supports and attachments for piping, ductwork, lighting fixtures, cables, cable trays, raceways and conduit.
 - b. Building Roofs, walls, floors, windows, doors, and ceilings.
 - c. Suspended Ceilings components.
 - d. HVAC Equipment, piping, ductwork, controls devices, and associated electrical disconnects.
 - e. Size and Location of access doors and panels required for maintenance of products installed in walls and inaccessible ceilings.
 - f. Size and Location of penetrations through the finished floor.
 - g. Size and Location of penetrations through fire rated walls.

- h. Items penetrating the finished ceiling, including but not limited to:
 - 1) Air outlets and inlets
 - 2) Luminaires
 - 3) Fire Suppression Sprinklers
 - 4) Fire Alarm Components, such as horns and strobes
 - 5) Life Safety Components, such as exit signs
 - 6) Mass Notification Components, such as speakers
 - 7) IT components, such as routers
 - 8) Security components, such as cameras
 - 9) Service Access Panels
- C. Substantial Completion Submittals: These submittals are required prior to achieving substantial completion from the Architect or Engineer of Record. One hard copy shall be turned over to the Owner's Maintenance Staff at Owner Training.
 - 1. Record Drawings Submittal reviewed with "No Exceptions" by Architect and/or Engineer of record.
 - 2. Commissioning Documentation as required by other specification sections provided in .PDF file format on a USB Thumb-drive and one printed copy organized by specification section in multiple three ring binders not to exceed 4", including at minimum:
 - a. Start Up Reports for all HVAC Equipment and components.
 - b. Testing, Adjusting and Balancing report returned with "No Exceptions" by the Architect and/or Engineer of record.
 - c. Manufacturer's Operation and Maintenance Data for all HVAC system Products, including all accessory sizes required, such as belt and filter sizes and types.
 - d. Emergency Service Contact including Name, email address, and Phone Number.
 - e. Written Record from Owner stating Owner's Representative system training has been successfully delivered.
 - 3. Service Valve Tag Chart and Location Maps.
 - 4. Updated Control Valve Schedule.
 - 5. Field Reports indicating successfully completing Ductwork Leakage Testing.
 - 6. Field Reports indicating successfully completing Piping Pressure Testing.
 - 7. Any and all maintenance required items as specified in other Division 23 Sections in packages with protective cover for storage and identified with labels describing contents and intended use. (i.e. FAN BELT – AHU-1 SUPPLY FAN)

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Where feasible, arrange for product delivery to the construction site when construction has progressed to allow for delivery to the final installed location protected from the weather and site security is sufficient to prevent easy theft (lockable door, container, or cage area and/or a night guard).
- B. Deliver all pipes with factory applied end caps. Caps shall be maintained through shipping and storage until such time pipe is being installed to prevent entrapment of debris and contaminants and minimize pre-construction corrosion of materials.
- C. Do not allow any materials to be stored exposed to weather, standing water, excessive dirt and dust, or in a manner to prevent the flow of traffic through the worksite.

- D. Handle all products with care and per manufacturer's written instructions for lifting and rigging. Do not install damaged items without written consent from the Owner.

1.5 COORDINATION

- A. The drawings indicate the general arrangement, routing, and scope of the systems and are to be followed as often as possible. Deviations from the drawn layout are permissible, if necessitated by field conditions and approved by the Architect or Engineer of Record through submittal and properly coordinated with all other trades.
- B. The drawings are not intended to show every minor vertical and/or horizontal offset required to navigate a complete installation of the system due to obstructions that may arise due to field conditions. Contractors shall anticipate potential additional offsets in their construction proposals.
- C. The drawings, schedules, and specifications shall be considered one cooperative document. Items may or may not appear in both drawings and specifications. Anything appearing in one or the other location shall be considered included in the contract documents and the contractor shall provide a bid based inclusive of both Specifications and Drawings. Any and all identified conflicting statements between the Specifications and Drawings that affects the final bid price shall be submitted for clarification during the bidding process.
- D. New Equipment: All equipment provided by the contractor shall be provided as "new" and not "used". Contractor shall not energize equipment prior to substantial completion unless:
 - a. Factory Representative and/or Owner's Representative is in attendance for start-up testing.
 - b. The Test, Adjusting and Balancing Contractor is actively testing the equipment
 - c. Specific, written authorization from the Owner has been granted for:
 - i. Space Pressurization in conjunction with approved pressurization plan.
 - ii. Space Tempering during finish installation.
- E. Contractor shall field verify all measurements in the field and shall be responsible for the correct fitting of all systems and components. Contractor shall coordinate all work with other branches and trades to minimize conflict and delays. Contractors shall:
 - a. Coordinate work plan in advance with all other trades and immediately upon discovery, report any anticipated difficulty with proposed resolutions to the general contractor and/or Architect or Engineer of Record.
 - b. Provide the General Contractor and Owner with a detailed schedule to be incorporated within the overall construction schedule to include at minimum:
 - i. Any necessary demolition, as phased by floor and area.
 - ii. Temporary Construction as required to maintain any existing services.
 - iii. Coordination Efforts
 - iv. Architectural Rough Ins – i.e. wall and floor sleeves installation.
 - v. Product Submittals
 - vi. Shop Drawing Submittals
 - vii. Product Procurement and storage

- viii. Product Installation
 - ix. Duct and Piping Installation
 - x. Installation of Insulation and Identification Systems
 - xi. Start-Up and Commissioning of Equipment
 - xii. Owner Training
 - xiii. Punch List Inspection
 - xiv. Substantial Completion
 - c. Coordinate space needs of ductwork, piping, chases, wall, floor, and roof penetrations, with other trades during construction to allow for easy installation.
 - d. Coordinate installation of all structural supporting elements, sleeves, sleeve seals, etc. through cast-in-place concrete and other structural components as they are constructed.
 - e. Coordinate requirements for all access hatches, panels, doors, hand holes for HVAC items during work planning for wall and ceiling construction. Access panels and doors are specified in Division 08.
 - f. Coordinate any and all trenching, excavating, bedding, and backfilling with general contractor and appropriate piping specifications and earthwork specifications in other divisions.
 - g. Coordinate any HVAC Demolition with all aspects of demolition and temporary construction by other trades, including dust barriers and electrical demolition. Do not remove electrical components of HVAC equipment without electrical components first being locked out and removed by Division 26 demolition contractor.
- F. Existing Conditions: For renovation of existing facilities which are occupied:
- a. Do not interrupt the utilities serving existing facilities while occupied or partially occupied without coordinated arrangement for temporary utilities according to the requirements listed and written approval from the Owner.
 - i. Do not proceed with proposed utility interruptions without permission from the Owner.
 - ii. Submit a utility outage plan for approval by the Owner no less than seven (7) days prior to include, at minimum:
 - 1. Utilities to be disrupted.
 - 2. Length of disruption.
 - 3. Plan for Fire Watch
 - b. Coordinate installation of new products and systems with all existing installations which are existing to remain in the project area, including but not limited to:
 - i. Plumbing, including domestic water, sanitary waste and vent piping and storm drain piping.
 - ii. Fire protection and suppression piping.
 - iii. HVAC Service Piping, including heating, cooling, condenser, steam, condensate, compressed air, and refrigerant piping.
 - iv. Piping Expansion Fittings
 - v. Ductwork
 - vi. Electrical Conduit, Cable Tray, Raceway
 - vii. Lighting Fixtures and Luminaires

- viii. Existing IT Infrastructure, including wireless routers, cabling, and wire trays.
- ix. Existing Security Infrastructure, including cameras, and door contactors and operators
- x. Existing Fire Alarm and Life Safety Infrastructure, including smoke and fire detectors, annunciators, strobe lights, exit signs, and extinguishers.
- c. Provide Shop Drawings for all connections to existing systems including transitions in ductwork and pipe fittings.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance requirements, provide a product from one of the listed manufacturers. Any manufacturer specifically mentioned on the drawing shall be considered Basis – of – Design.
- B. Available or Acceptable Manufacturers: Manufacturers of known equivalence. When listed, provide a product by one of the manufacturers listed or submit a non-listed manufacturer's product for review. Contractor is responsible for all cost deviations arising from use of a non-listed manufacturer.

2.1 ELECTRICAL REQUIREMENTS

- A. Electrical Characteristics for HVAC Equipment: Unless otherwise approved, supply equipment with the electrical characteristics as indicated in the contract documents.
- B. Equipment with electrical characteristics different from those indicated in the contract documents shall only be supplied if the following is approved in writing:
 - a. The electrical supply wiring and conduit size is properly coordinated and modified.
 - b. The electrical over-current protection device is properly coordinated and modified.
 - c. The changes associated with panelboards, local transformers, and disconnects are properly coordinated and modified.
 - d. Any additional costs of other contractors associated with the change in electrical characteristics are the responsibility of the Mechanical Contractor.

2.2 PIPE, TUBE, AND FITTINGS

- A. See Section 231113 Hydronic Piping and 231116 Hydronic Piping Specialties
- B. See Section 232300 Refrigerant Piping

2.3 DUCTWORK

- A. See Section 233100 HVAC Ducts and Casings and 233300 Duct Accessories

2.4 GROUT

- A. Description: ASTM C 1007B, nonshrink and nonmetallic, dry hydraulic-cement grout
 - a. Post Hardening, volume adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications
 - b. 5000-PSI, 28-day compressive strength

- c. Premixed or packaged

2.5 JOINING MATERIALS

- A. Refer to Division 23 Piping Sections for special joining materials not listed below. When joining materials are in conflict, utilize the joining materials specified in the piping specific application specification.
- B. Pipe-Flange Gasket Materials: Suitable chemical and thermal conditions for the specific use of the piping as specified in other Division Piping Sections
 - a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless otherwise indicated
 - i. Full-Face: Flat-Face, Class 125, cast-iron and cast-bronze flanges
 - ii. Narrow-Face: Raised-Face, Class 250, cast-iron and steel flanges
 - b. AWWA C110, rubber, flat face, 1/8-inch-thick, full face or ring type, unless otherwise indicated
- C. Flange Bolts and Nuts: ASME B182.1, Carbon Steel, unless otherwise indicated
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material as recommended by piping system manufacturer for intended service, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys with ASTM B 813 water flushable flux. Melting point suitable for service.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorous alloys for general-duty brazing, unless otherwise indicated.
 - a. Refrigerant Piping Brazing Filler Metals: AWS A5.8, Bagl, Silver alloy, unless otherwise specified by the manufacturer's written installation instructions.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for the wall thickness and chemical composition of the steel pipe being welded.
- H. Solvent Cements for Plastic Pipe
 - a. PVC Piping:
 - i. Solvent Cement: ASTM 2564
 - ii. Primer: ASTM F 6565
 - b. CPVC Piping:
 - i. Solvent Cement: ASTM 493

PART 3 - EXECUTION

3.1 PRE-WORK INSPECTION

- A. Examine the work area before beginning installation. Ensure
 - a. Conditions are safe and satisfactory for working.
 - b. Rough-In work is installed properly.

- c. All coordination activities are successfully completed.
 - d. The area is free of conflicts to proper installation.
- B. Do not proceed with work if conditions are unsatisfactory.

3.2 PLANNING

- A. Plan work beforehand.
- B. Communicate work plan to other contractors performing work in the area.
- C. Coordinate all work as listed in the Coordination Section of this specification.

3.3 HVAC DEMOLITION

- A. Refer to general demolition specifications in division 02.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components as indicated.
 - a. To Be Removed: Uninstall and remove from site, including all insulation, pipe or ductwork, hangers and supports, specialties, and appurtenances as indicated. Cap at limits of demolition with same or compatible material if portion of service is existing to remain.
 - b. To Be Abandoned in Place: Disconnect from main service, drain, clean, and cap with same or compatible material.
 - c. Existing to Remain: Do not remove. Contractor is responsible for maintaining in a serviceable condition during work.
- C. Contractor shall be responsible for replacing and repairing items that are existing to remain yet damaged by the contractor during work.

3.4 INSTALLATION

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

3.5 CONCRETE BASES

- A. Anchor equipment to concrete base according to equipment manufacturer's published installation instructions and in accordance with seismic requirements, if present.
- B. Construct concrete bases of dimensions indicated, but not less than 6 inches larger than supported unit in all directions.
- C. Install dowel rods 18 inches on center to connect concrete base to concrete floor.
- D. Install epoxy-coated anchor bolts for supported equipment that extends through the concrete base and anchor to structural floor.

- E. Place and secure anchorage devices using supported equipment manufacturer's published documentation, including setting drawings, diagrams, templates, instructions furnished with equipment to be supported.
- F. Use 3000 PSI 28-day compressive strength concrete and reinforcements as specified in Division 03.
- G. Ensure anchor bolts have proper exposed elevation to properly secure equipment to base.

3.6 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surface, pump, and other equipment base plates, and anchors.
- B. Clean all surfaces to be grouted prior to installing grout.
- C. Provide forms as needed to properly install grout.
- D. Place grout, completely filling bases and forms.
- E. Avoid entrapment of air within the grout during installation.
- F. Place grout on concrete bases and provide smooth and level bearing surfaces for equipment to be supported
- G. Place grout around anchors.
- H. Cure placed grout.

3.7 METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel requirements.
- B. Metal Channel ("strut") products in accordance with the Metal Framing Manufacturer's Association standards may be used for metal framings, supports, and anchorages.
- C. Cut, fit, and place miscellaneous metal supports accurately in locations as needed, with proper alignment and elevation required to support and anchor HVAC materials and equipment as intended in the contract documents.
- D. Field Welding shall comply with AWS D1.1

3.8 WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages as needed to support and anchor HVAC equipment and materials.

- B. Select fasteners that will not penetrate wood members through a finished or exposed side. Tighten connections between members. Do not install fasteners resulting in split or weakened wood members.
- C. Attach to substrates as required to support the sum of the dead load and applied working load of supported equipment.

3.9 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Contractor shall confirm proper fit of equipment.
- B. Install equipment level and plumb.
- C. To the extent possible, install equipment and products perpendicular and parallel to exterior walls unless otherwise indicated.
- D. Install equipment perpendicular and parallel to other building systems and components unless otherwise indicated.
- E. Install all HVAC products and equipment:
 - a. To maximize headroom if specific mounting height is not specified.
 - b. To facilitate maintenance and service.
 - c. To maintain manufacturer's recommended minimum clearances.
 - d. To meet NFPA 70 required clearances to electrical components.
 - e. To allow space for installation of necessarily sloped items at intended slope.
- F. Connect equipment for ease of disconnecting and removing, with minimum interference to other installations
- G. Extend grease fittings to accessible locations outside of motor compartments and equipment casings.

3.10 CLEANING AND RESTORATION

- A. Contractor shall repair damage resulting from the contractor's work.
- B. Leave the work area broom clean at the end of each work shift.
- C. Thoroughly clean the work area at the completion of construction. At a minimum, Contractor shall:
 - a. Remove all excess grout, paint, plaster, caulk, firestopping, or other products used during installation of HVAC systems from finished surfaces.
 - b. Clean duct systems clear of construction debris and dust.
 - c. Clean the blowers, fan housings, discharge plenums, scrolls, blades, vanes, shafts, baffles, dampers, and drive assemblies of all air handling units and fans free of construction debris and dust.

- d. Clean all coils dust free and render Coil Visibly Clean and within 10% of design coil pressure drop.
- e. Clean all drain pans free of debris and dust.
- f. Clean all dust from diffusers, registers, and grilles.
- g. Clean, empty, and replace all strainer baskets.
- h. Clean debris from all insect and bird screens.
- i. Install new, clean air filters.
- j. Remove all trash from mechanical equipment rooms.
- k. Sweep clean all mechanical rooms.
- l. Remove dust from exposed equipment casings.
- m. Ensure all equipment tags and labels are clean and legible.

3.11 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to start up, test, and inspect mechanical equipment components, assemblies, connections, and installations as indicated.
- B. Non-Conforming Work: Items shall be deemed defective if they do not pass tests and inspections, including commissioning functional testing.

3.12 FIELD PAINTING

- A. When field applied coatings are specified, painting of HVAC Systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Marred, scratched, dinged, or otherwise damaged factory finishes shall be repaired with materials to match original factory finish using the manufacturer's approved methods.

3.13 OWNER TRAINING

- A. Contractor shall provide training to the Owner's maintenance personnel on the systems and equipment installed. Training shall include, at a minimum:
 - a. Means of turning equipment on and off safely.
 - b. Review of Equipment Sequences and Operation.
 - c. Review of Equipment Capacities and Capabilities.
 - d. Means of making minor adjustments to setpoints.
 - e. Review of Building Automation Systems.
 - f. Basic Maintenance requirements.
 - i. Filter Change Parameters and procedures.
 - ii. Fan Belt Change Procedures.
 - iii. Bearing Grease extension locations.
 - iv. Greasing Intervals.
 - v. Strainer cleaning procedures and intervals.
 - vi. Turnover of Substantial Completion Hard Copy.

END OF SECTION 230000

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
- B. Related Sections:
 - 1. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 2. Section 260553 - Identification for Electrical Systems.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Action Submittals:
 - 1. Product Data:
 - a. Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, maintenance procedures and intervals, and support points.
 - b. Submit data for each motor furnished as a package with the package submittal. Indicate nameplate and performance data, standard compliance, electrical ratings and characteristics and maintenance procedures and intervals.
 - 2. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
- C. Information Submittals:

1. Motor Manufacturer's published Operation and Maintenance Data, to be included in close out submittals.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.
- B. Testing Agency: Company specializing in testing products specified in this section with minimum three <3> years' documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

1.6 COORDINATION

- A. Coordinate all features of motors, installed units, and accessory devices to be compatible with:
 1. Means of Motor Starting.
 2. Torque, speed, and mechanical power requirements of the application.
 3. Ratings and characteristics of the electrical supply circuit.
 4. Means of speed control.
 5. Ambient and environmental conditions, both during storage and in the final installed location.
- B. Coordinate all motor installation requirements with Division 26 contractor.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 1 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 1 hp: Single-phase motor may be supplied as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

- C. Three-Phase Motors: NEMA MG 1, Design B, premium-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
1. Voltage: As indicated on Drawings
 2. Service Factor: 1.15
 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 5. Design Code: Design B
 6. Insulation System: NEMA Class F.
 7. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 8. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 9. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 10. Sound Power Levels: Conform to NEMA MG 1.
- D. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 2. Voltage: as indicated on the drawings, single phase, 60 Hz.
- E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 THREE-PHASE MOTORS FURNISHED LOOSE

- A. Acceptable Manufacturers: Acceptable Manufacturer's are listed below. Other manufacturers of equivalent products may be submitted for review.
1. General Electric
 2. Siemens
 3. Baldor
 4. Marathon Electric Company
- B. Product Description: NEMA MG 1, Design B, premium-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds indicated.
- C. Voltage: as indicated on the drawings, three phase, 60 Hz.
- D. Service Factor: 1.15

- E. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated.
- F. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- G. Insulation System: NEMA Class F.
- H. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- I. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
- J. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- K. Sound Power Levels: Conform to NEMA MG 1.
- L. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.3 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors in accordance with motor manufacturer's requirements.
- B. Install engraved plastic nameplates in accordance with Section 260553 for all motors.
- C. Electrical Installer shall provide and install all necessary materials and labor to ground and bond motors in accordance with Section 260526.

3.2 FIELD QUALITY CONTROL

- A. Perform inspections listed in NETA ATS, Section 7.15 for Rotating Machinery.
- B. Perform Insulation Resistance Testing on all motor installations for the nominal voltage rating of the equipment. Motors that do not meet the minimum insulation resistance value tabulated in

ICI Warehouse Expansion Project

ANSI/NETA ATS-2009, summarized below, shall be reworked or replaced until the motor passes testing.

Nominal Rating of Equipment (volts)	Minimum Test Voltage, DC	Minimum Insulation Resistance in Megohms
<250	500	25
250 < Rated Volts < 600	1,000	100

END OF SECTION 230513

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-Seal Systems.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data for each type of product to be installed.

B. Information Submittals:

1. Maintenance Data: For each type of product to be installed.

PART 2 – PRODUCTS

2.1 SLEEVES

- A. All wall and floor pipe penetration sleeves up to 24" and less than 150°F can be molded non-metallic, non-corrosive, high density polyethylene and formed to have a water stop and anchor plate at least 4" larger than the outside diameter of the sleeve itself. End caps with nailing flanges shall be provided on each end to facilitate attaching the sleeve to the wall form and to prevent deformation during the concrete pour. End caps shall remain in place to protect the opening from foreign debris and rodent entry until it is penetrated by the pipe, tubing, or conduit. Century Line model CS by Link-Seal, Metraflex, or prior approved.
- B. For openings from 29.25" to 64" contractor can be Link-Seal's Cell-Cast disks, providing a round hole in conformance with Link-Seal sizing data. Cell-Casts shall consist of 3" and/or 4" lightweight interlocking polyethylene cells stacked to form the thickness of the poured concrete wall. Molded into each cell shall be a cavity to accept a 2" x 4" nailer.
- C. Contractor shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by Faco or the manufacturer to fit the pipe and Link-Seal to assure a water-tight and air-tight seal.
- D. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to the ductile iron pressure pipe, with plan ends and integral waterstop unless otherwise indicated.

- E. Galvanized-Steel Wall Pipes: ASTM A 53/53M Schedule 40, with plan ends and welded steel collar; zinc coated.
- F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/53M, Type E, Grade B, Schedule 40, zinc coated with plain ends.
- G. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness with round tube, closed with a longitudinal joint.
- H. PVC-Pipe Sleeves: STM D 1785 Schedule 40.
- I. Molded-Polyethylene or Polypropylene Sleeves: Removable, tapered cup shaped, smooth outer surface with nailing flange to attach to framing member.
- J. Molded PVC Sleeves: With nailing flange to attach to framing member.

2.2 SLEEVE SEAL SYSTEMS

- A. Acceptable Manufacturers: Acceptable Manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.
 - 1. Metraflex
 - 2. Advance Products & Systems
 - 3. GPT
 - 4. Link-Seal
 - 5. Pipeline Seal and Insulator
- B. Description: Modular sealing-element unit, designed for assembly in the field, intended to fill annular space between piping and pipe sleeve.
 - 1. Basis of Design Product: Link-Seal
 - 2. Sealing Pressure: 20 PSIG air and / or 40 ft Head water.
 - 3. Sealing Elements: EPDM-Rubber interlocking links shaped to fit pipe surface snug. Include type and number required for pipe size and material.
 - 4. Pressure Plates:
 - a. Glass reinforced plastic, under maximum media temperature of 250 degrees F.
 - b. Steel, Zinc Dichromate over maximum media temperature of 250 degrees F or when exposed to weather.
 - 5. Connecting Bolts and Nuts:
 - a. Carbon Steel with an organic resin coating for corrosion resistance of greater than ten years for interior installations.
 - b. 316 Stainless Steel or equivalent corrosion-resistant hardware for underground or exterior wall penetrations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install sleeves for piping penetrations through all floors, walls, partitions, and roofs.

1. Install sleeves in concrete floors, roof slabs, and walls as new floor, slab, or wall is constructed.
 2. Select sleeves to receive sleeve seal systems to have at least a nominal 1-inch annular space between piping and concrete, excluding insulation.
 3. Select sleeves not receiving sleeve seal systems to have 1/4 - inch clear annular space between sleeve and insulation of piping system.
 4. Cut sleeves to length such that sleeve is flush with both finished surfaces.
 - a. All sleeves in through floors in mechanical rooms shall extend 2" above finished floor surface.
 5. Install piping through center of sleeve. Align centerlines of sleeve and pipe.
 6. Fill the area outside of sleeves with grout.
 7. Fill the annular area inside of sleeves without sleeve seal systems with caulk. Piping insulation of the pipe penetrating shall have an insulation jacket compatible with the caulk. Refer to section 079200 for "Joint Sealants" for non-fire rated walls.
 8. For all penetrations through Fire-Barriers, maintain the indicated rating of the barrier. Seal pipe penetration with firestop materials. Comply with firestopping requirements as specified in section 078413 "Penetration Firestopping"
- B. Install sleeve-seal-systems in exterior walls, and piping service installations through slabs-on-grade.
1. Select type, size, and number of sealing elements required for penetrating pipe characteristics per manufacturer's written instructions.
 2. Align the centerline of installed piping with the centerline of pipe sleeve.
 3. Install sleeve-seal-system links in annular space per manufacturer's published instructions.
- C. Install weatherproof wall box penetrations per manufacturer's written instructions.

END OF SECTION 230517

SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes:
 - a. Escutcheons.
 - b. Floor plates.

1.2 SUBMITTALS

- A. Action Submittals:
 - a. Product Data for each type of product indicated.

PART 2 – PRODUCTS

2.1 ESCUTCHEONS

- A. One-piece, steel type: With polished, chrome-plated finish and set screw fastener.
- B. One-piece, stainless steel type: With polished, stainless steel finish.
- C. One-piece, stamped steel type: with polished, chrome-plated finish and spring-clip fastener.
- D. One-piece, deep-pattern type: Deep-draw, box-shaped steel with polished, chrome-plated finish and spring clip fastener.
- E. Split-plate, stamped steel type: with polished, chrome-plated finish; concealed or exposed rivet hinge and spring clip fastener.

2.2 FLOOR PLATES

- A. Split floor plates: Steel with concealed hinge.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for all interior exposed piping penetrations through floors, walls, and ceilings.
- B. Install escutcheons with inside diameter closely fitting around outside diameter of piping and piping insulation and outside insulation completely covering opening and pipe sleeve.
- C. Install escutcheons fitting to the piping type:

- a. Pipe Sleeve through wall: one-piece deep pattern.
 - b. Uninsulated piping: Split Plate Steel.
 - c. Insulated Piping: Split Plate Steel.
- D. Install floor plates for piping penetrations through mechanical room floors that do not have extended pipe sleeves.
- E. Install floor plates with the inside diameter loosely fitting around piping and pipe insulation and the outside diameter covering the pipe sleeve and opening completely.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Pipe Stands.
3. Pipe Support Accessories.
4. Flashing.
5. Equipment curbs.
6. Formed steel channel.
7. Equipment bases and supports.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:

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

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment.
- C. Firestopping Materials: Comply with requirements of Section 078400.
- D. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Action Submittals:

1. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
2. Product Data: Submit manufacturers catalog data including load capacity for all hangers, supports, stands, rods, and structural channel products.
3. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods sealed by a registered professional engineer.
4. Manufacturer's Installation Instructions:
 - a. Hangers and Supports: Submit special procedures and assembly of components.
 - b. Firestopping: Submit preparation and installation instructions.
5. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

C. Informational Submittals:

1. Welding Certificates.
2. Operational and Maintenance Data for all products installed.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience or as approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Provide ventilation in areas to receive solvent cured materials.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Acceptable Manufacturers: Acceptable Manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.
1. Anvil International
 2. B-Line Systems
 3. Empire Industries, Inc.
 4. ERICO/Michigan Hanger Co.
 5. Globe Pipe Hanger Products
 6. Grinnel Corp.
 7. Hilti
 8. National Pipe Hanger Corp.
 9. PHD Manufacturing, Inc.
- B. General Descriptions:
1. Carbon-Steel Pipe Hangers and Supports
 - a. Factory fabricated, galvanized Carbon-steel MSS SP-58, Types 1 through 58, pipe hangers.
 - b. Plastic Coated, Jacketed, or lined as required.
 - c. Padded with fiberglass or other pipe insulation pad or cushioning to support bearing surface of piping.
 2. Saddles:
 - a. Galvanized steel, 180 degree shaped, marked with insulation outside diameter.
 - b. Standard manufacturer's size to correspond to insulated pipe size.
 3. Copper Pipe Hangers
 - a. Factory fabricated, copper-coated-steel MSS SP-58, Types 1 through 58
 4. Trapeze Pipe Hangers:
 - a. Shop or Field Fabricated pipe support assembly compliant with MSS SP-69, Type 59, made from structural carbon steel shapes and hanger rods, nuts, saddles, and U-Bolts compliant with MSS SP-58.
- C. Hydronic Piping hangers:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 inch and Larger: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.

5. Hangers for Hot Pipe Sizes 6 inch and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches (76 mm) and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inch and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inch and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.
- 16.

D. Refrigerant Piping Hangers:

1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inch and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods or approved structural strut product.
5. Wall Support for Pipe Sizes 3 inch and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 PIPE STANDS

- A. General Description: Shop or field fabricated assemblies made of corrosion resistant components to support roof or ground mounted piping.
- B. Low-type, Single-Pipe Stand: One-piece plastic, stainless steel, or rubber base unit with a plastic roller for installation on a roof without penetrating the membrane. Include roof pads between stand and membrane.
- C. High-Type, Single- or Multiple-Pipe Stands: Base or Assembly of bases, vertical and horizontal members, pipe supports, and pipe support accessories for hanging or setting pipe on a roof without penetrating a membrane.
 1. Plastic, stainless steel, or rubber base, one or more.
 2. Two or more vertical structural steel or channel, protectively coated.

3. Two or more horizontal structural steel or channel, protectively coated.
 4. Pipe supports set on top of bottom horizontal member or hung from top horizontal member.
- D. Curb Mounted Stands: Shop- or Field-fabricated pipe supports made from structural steel or channel, threaded rods, rollers, and other pipe hangers and accessories, mounted on a permanent, stationary roof curb.

2.3 PIPE SUPPORT ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.
- B. Thermal Shield Inserts
1. Cold Pipe: ASTM C 552 Type II Cellular glass with 100-PSIG or ASTM C 591, Type VI Grade I polyisocyanurate with 125 PSIG minimum compressive strength vapor barrier.
 2. Hot Pipe: Water repellant treated, ASTM C 533, Type I Calcium silicate with 100-PSIG ASTM C 552, Type II cellular glass with 100 PSIG, or ASTM C 591, Type VI, Grade I, polyisocyanurate with 125-PSIG minimum compressive strength.
 3. Metal shield shall cover lower 180 degrees of pipe in clevis and band hangers, full pipe circumference for pipe in trapeze and clamp hangers.
 4. Insert shall extend a minimum of 2 inches beyond shield metal shield.

2.3 FLASHING

- A. Metal Flashing: Minimum 26 gage thick galvanized steel unless otherwise indicated by the Architectural specifications and details.
- B. Metal Counterflashing: Minimum 22 gage thick galvanized steel unless otherwise indicated by the Architectural specifications and details.
- C. Flexible Flashing: Minimum 47 mil thick sheet unless otherwise indicated by the Architectural specifications and details, compatible with roofing.
- D. Caps: Steel, minimum thickness 22 gage minimum; minimum thickness 16 gage at fire resistant elements.

2.4 EQUIPMENT CURBS

- A. Acceptable Manufacturers: To all feasible extents, utilize the equipment manufacture's curbs. When a third-party curb is required, then select from the Acceptable Manufacturers listed below. Other manufacturers of equivalent products may be submitted for review.
1. LM Curbs
 2. Metal Form Manufacturing
 3. Pate Company
 4. Roof Products, Inc.

- B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, minimum 1-inch insulation, glued and pinned.

2.5 FORMED STEEL CHANNEL

- A. Acceptable Manufacturers: Acceptable Manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.
 - 1. Unistrut
 - 2. B-line by Eaton
 - 3. Hilti
- B. Product Description: Galvanized 12 gage thick steel with holes at regular intervals, 2-inch or less, on center.

2.6 FIRESTOPPING

- A. Firestopping Materials: Comply with requirements of Section 078400.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Do not drill or cut structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.

- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inch (100 mm) and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with the same ASME B31 section as listed in common requirements, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Prime coat exposed steel hangers and supports. Refer to Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- N. Pipe Stand Installation
 - 1. Pipe stand types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stands and mount on permanent, stationary roof curb.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 4-inch-thick and extending 6 inches beyond supported equipment. Refer to Section 033000.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 210548.

3.6 INSTALLATION - FLASHING

- A. Refer to Architectural specifications for Flashing and Waterproofing. When Architectural sections do not explicitly state requirements:
 - 1. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
 - 2. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
 - 3. Provide curbs for roof installations 14 inch minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.
 - 4. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting, testing.
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.10 SCHEDULES

A. Copper Tube Hanger Spacing:

- 1. Pipe Size 1-1/4 Inch and smaller:
 - a. Maximum Horizontal Hanger Spacing: 6 feet.
 - b. Maximum Vertical Spacing: 10 feet or at each floor penetration.
 - c. Hanger Rod Diameter: 3/8 inch.
- 2. Pipe Size 1-1/2 Inch and larger
 - a. Maximum Horizontal Hanger Spacing: 10 feet.
 - b. Maximum Vertical Spacing: 10 feet or at each floor penetration.
 - c. Hanger Rod Diameter: 1/2 inch.

B. Steel Pipe Hanger Spacing:

- 1. Pipe Size 3 inch and smaller:
 - a. Maximum Horizontal Hanger Spacing: 10 feet.
 - b. Maximum Vertical Spacing: 15 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 1/2 inch.
- 2. Pipe Size over 3 inch and under 6 inch:
 - a. Maximum Horizontal Hanger Spacing: 12 feet.
 - b. Maximum Vertical Spacing: 15 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 5/8 inch.
- 3. Pipe Size 6 inch and over but and under 10 inch:
 - a. Maximum Hanger Spacing: 12 feet.
 - b. Maximum Horizontal Vertical Spacing: 15 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 3/4 inch.
- 4. Pipe Size 10 inch and over but under 14 inch:
 - a. Maximum Hanger Spacing: 12 feet.
 - b. Maximum Horizontal Vertical Spacing: 15 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 7/8 inch.
- 5. Pipe Size 14 inch and over but under 20 inch:
 - a. Maximum Hanger Spacing: 12 feet.
 - b. Maximum Horizontal Vertical Spacing: 15 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 1 inch.

C. Plastic Pipe Hanger Spacing:

1. Pipe Material: ABS.
 - a. Maximum Horizontal Hanger Spacing: 4 feet.
 - b. Maximum Vertical Support Spacing: 10 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 1/2 inch.
2. Pipe Material: FRP.
 - a. Maximum Horizontal Hanger Spacing: 4 feet.
 - b. Maximum Vertical Support Spacing: 10 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 1/2 inch.
3. Pipe Material: PVC.
 - a. Maximum Horizontal Hanger Spacing: 4 feet.
 - b. Maximum Vertical Support Spacing: 10 feet or at each floor penetration.
 - c. Minimum Hanger Rod Diameter: 1/2 inch.

END OF SECTION 230529

SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes vibration and seismic isolation devices for HVAC.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.3 SUBMITTALS

- A. Action Submittals:

1. Product Data: For each type of product.
 - a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - 1) Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction
 - 2) Annotate to indicate application of each product submitted and compliance with requirements.
 - c. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
2. Shop Drawings:
 - a. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

- a. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- b. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind (where applicable) restraints and for designing vibration isolation bases.
 - 1) Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
- c. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
- d. Seismic and Wind-Restraint Details:
 - 1) Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - 2) Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - 3) Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - 4) Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Informational Submittals:

- 1. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- 2. Qualification Data: For professional engineer.
- 3. Welding certificates.
- 4. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing lab as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading: Refer to Drawings.

2.2 ELASTOMERIC ISOLATION PADS

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

2.3 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:

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

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

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

2.5 OPEN-SPRING ISOLATORS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.

- c. Novia; A Division of C&P.
- 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
- 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

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

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

2.7 RESTRAINED-SPRING ISOLATORS

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

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

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

2.9 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

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

2.11 ELASTOMERIC HANGERS

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

2.12 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Novia; A Division of C&P.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Novia; A Division of C&P.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

2.14 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. B-line, an Eaton business.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut; Part of Atkore International.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building

structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Novia; A Division of C&P.
- B. Restraint Cables: ASTM A 492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.16 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. B-line, an Eaton business.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. Novia; A Division of C&P.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.17 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. B-line, an Eaton business.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.18 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.19 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Novia; A Division of C&P.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Low mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.20 RESTRAINED ISOLATION ROOF-CURB RAILS

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 3 Sections.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Division 7 Sections for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet on center, and longitudinal supports a maximum of 80 feet on center or as required by authority having jurisdiction.
 - 3. Brace piping longer than 12 feet after a change of direction.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- K. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in other Division 23 Sections for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' notice.
 3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.

- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

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

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 SUBMITTALS

A. Action Submittals:

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

B. Closeout Submittals:

1. Valve Schedules: For each piping system to include in operation and maintenance data.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

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

B. Plastic Labels for Equipment:

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

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

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

2.2 WARNING SIGNS AND LABELS

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

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

2.3 PIPE LABELS

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

2.4 DUCT LABELS

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

2.5 VALVE TAGS

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

2.6 WARNING TAGS

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

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

3.3 EQUIPMENT LABEL INSTALLATION

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

3.4 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve or control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. Condenser-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 3. Heating Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White
 - 4. Refrigerant Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.5 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold-air supply ducts.
 - 2. Yellow: For hot-air and variable temperature supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

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

3.7 WARNING-TAG INSTALLATION

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

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing air systems.
2. Balancing hydronic water piping systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

A. Action Submittals:

1. Certified TAB reports.

B. Informational Submittals:

1. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
2. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
3. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and certified by AABC or NEBB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard AABC or NEBB TAB forms.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 COORDINATION

- A. Notice: Provide at least seven days' notice before each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.6 HVAC CONTRACTOR RESPONSIBILITIES

- A. Provide TAB agency one complete set of contract documents, change orders, and approved submittals in digital pdf format.
- B. Control contractor shall provide required BAS hardware, software, personnel, and assistance to TAB agency as required for TAB agency to balance the systems. Control contractor shall also provide trending reports as needed to demonstrate that systems are complete.
- C. Coordinate meetings and assistance from suppliers and contractors as required by TAB agency.
- D. Provide additional valves, dampers, sheaves and belts as required by TAB agency.
- E. Flag all manual volume dampers with high-visibility tape.
- F. Provide access to all dampers, valves, test ports, nameplates, and other appurtenances as required by TAB agency.
- G. Remove and replace or repair insulation as needed to provide access for the TAB work.
- H. Have the HVAC systems at complete operational readiness before TAB begins.
- I. Promptly correct deficiencies identified during TAB.
- J. Maintain a construction schedule that allows the TAB agency to complete work prior to occupancy.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, automatic flow control valves and fittings, and manual volume dampers. Verify that these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC systems and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenums are sealed (and fire-stopped if required).
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that might cause reduced capacities.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment under actual installed conditions. Use tables and charts in AMCA 201, "Fans and Systems" or in SMACNA "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, clean filters are installed, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, verifying that they are accessible and that their controls are connected, configured by the control contractor, and functioning.
- K. Examine two-way control valves for proper installation and function.
- L. Examine three-way valves for proper installation for their intended uses of diverting or mixing fluid flows and for proper function.
- M. Examine all equipment items to verify correct piping arrangements.

- N. Examine heat-transfer coils for correct piping connections and for clean and properly-spaced fins.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for each equipment item.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. General:
 - a. Electrical power wiring is complete.
 - b. Control systems are operational.
 - c. Access is provided to balancing and control devices.
 - d. Variable frequency drive start-up procedures are complete.
 - e. Safety devices are operational and indicating normal status.
 - 2. Air Side:
 - a. Ductwork is complete with air terminals installed.
 - b. Balance, fire, and smoke dampers are open and operational.
 - c. Control dampers are in their normal (fail) positions.
 - d. Equipment and duct access doors are securely closed.
 - e. Clean filters are installed.
 - f. Fans are operating and rotating in correct directions.
 - g. Fan vibration levels are within tolerance limits.
 - h. Building envelope is complete, and exterior windows and doors are closed.
 - 3. Hydronics:
 - a. Piping is complete with all terminal units installed.
 - b. Systems are flushed, filled, and purged of free air.
 - c. Strainers are clean, and startup strainer screens are removed.
 - d. Water treatment is complete.
 - e. Isolation and automatic flow limiting valves are open and operational. Drain valves are closed.
 - f. Control valves are in their normal (fail) positions.
 - g. Pumps are operating and rotating in correct directions.
 - h. Pump vibration levels are within tolerance limits.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC "National Standards for Total System Balance" or NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 2. Install new insulation where insulation is removed for TAB to match removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control devices, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of system "as-built" duct layouts with all components identified.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check condensate drains for proper connections and function.
- H. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AND VARIABLE-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow as follows:
 - a. Set outdoor air, return air, and relief air dampers for proper positions that simulate minimum outdoor air conditions.
 - b. Where conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.

- c. Where conditions are not suitable for duct Pitot-tube traverse measurements, a coil traverse may be acceptable.
 2. Where sufficient space is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Measure fan static pressures as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the discharge flexible connection.
 - c. Measure inlet static pressure of single-inlet fan at the fan inlet or through the inlet flexible connection.
 - d. Measure inlet static pressure of double-inlet fan through the wall of the plenum that houses the fan or through the inlet flexible connections.
 3. Measure static pressure across each component that makes up the air-handling unit, rooftop unit, or other air-handling equipment. Report the cleanliness status of filters and the time static pressures are measured. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 4. Adjust fan speed higher or lower than indicated speed as needed to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for ducts to indicated airflows within specified tolerances.
1. Measure airflows of branch ducts.
 2. Adjust branch duct balance dampers for specified airflows.
 3. Re-measure each branch duct after all have been adjusted.
- C. Adjust air outlets and inlets for each space to indicated airflows.
1. Adjust each outlet in same room or space to indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
 3. Measure airflows at all inlets and outlets.
 4. Adjust each inlet and outlet for specified airflow.
 5. Re-measure each inlet and outlet after all have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm minimum outdoor air, return air, and relief air flow rates are within design tolerances. Readjust as necessary.
 2. Re-measure and confirm total airflow is within design tolerance.
 3. Re-measure all final fan operating data. Include fan speeds, motor voltages, motor amperages, and static profiles.

4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation; adjust if necessary. Measure and record all operating data.
6. Record final performance data.

3.6 ADDITIONAL PROCEDURES FOR VARIABLE- VOLUME AIR SYSTEMS

A. Variable-Air-Volume Systems: Adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Verify that the duct static pressure sensors are installed and controlling the system.
3. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure inlet static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so terminal unit is calling for maximum airflow. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor. When maximum airflow is correct, balance the air outlets downstream from the terminal unit.
 - b. Adjust controls so terminal is calling for minimum airflow. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. Note any deviation from design airflow.
5. After all terminal units have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by the fan manufacturer.
 - a. Set outdoor air, return air, and relief air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflows so connected total matches fan selection and simulates actual load in the building.
6. Measure fan static pressure. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outdoor airflow rates to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return air ducts and inlets as described for constant-volume air systems.
 - b. Verify all terminal units are meeting design airflow rates under system maximum airflow conditions.

8. Re-measure the inlet static pressure at the most critical air terminal unit and adjust the system static pressure setpoint to the most energy-efficient setpoint to maintain optimum system static pressure. Record setpoint.
9. Re-measure the final system conditions as follows:
 - a. Re-measure and confirm minimum outdoor air, return air, and relief air flow rates are within design parameters. Readjust to design if necessary.
 - b. Re-measure and confirm total airflow rates are within design parameters.
 - c. Re-measure all final fan operating data.
 - d. Mark all final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust, if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.
 - g. Record final performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations beyond specified tolerances.
- B. Prepare schematic diagrams of system "as-built" piping layouts.
- C. Verify that hydronic systems are ready for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Check that makeup water has adequate pressure to highest vent.
 2. Check that air has been purged from the system.
 3. Open isolation. Close drain valves.
 4. Check motorized valves for specified sequence of operation, and set at indicated flow rates.
 5. Set differential-pressure control valves at the specified differential pressures. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Check pump-motor loads. If motors are overloaded, throttle flow so motor nameplate rating is not exceeded.
 7. Verify that motor starters are equipped with properly sized overload protection.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS WITH AUTOMATIC FLOW CONTROL VALVES.

- A. Preliminary Procedures
 1. Prior to adjusting pump operation, ensure that all boilers, chillers, pumps, and control valves are operational. Valves shall be in their design operation conditions.
 2. Verify that the GPM tags on all automatic flow control valves match the scheduled values for the coil. Report any discrepancies to the engineer.
 3. Check settings and operation of each safety valve. Record settings.
- B. Adjust pump operation as follows:

1. Set pump to operate at 60 Hz with all coil motorized control valves set fully open and system bypass valves set fully closed. Only operate the number of pumps that are intended to function at design conditions.
2. Measure the differential pressure across all boilers/chillers and measure the supply and return water temperature of all boilers/chillers. Only operate as many boilers/chillers as are intended to operate at design conditions at one time. If not all boilers/chillers operate at once, alternate which boilers/chillers are operational to take measurements for all of them. Perform the rest of the balancing using the worst-case boilers and chillers.
3. Measure the differential pressure across the autoflow control valves associated with the first coil and the 3 most critical coils for each system (highest pressure drop circuits). Also measure the supply and return water temperatures for the 3 critical coils.
4. Reduce the pump speed until the pressure drop across the critical automatic flow control valve (the AFCV with the lowest pressure drop) is no more than 3.0 psi above the minimum value for design flow through the AFCV.
5. Repeat steps 2-4 and record the final pressure drops and water temperatures for the boilers, chillers, the first AFCV, and the 3 critical AFCVs. Verify that all AFCV are still in the correct pressure drop range for design flow. Include these values in the report.
6. The system differential pressure setpoint shall be the differential pressure as measured in these conditions. Report this value to the controls contractor and include it in the TAB report.
7. Measure total water flow under these conditions and record this value for the report.
 - 1) Measure flow rate by main flow meter (if provided).
 - 2) If no main flow meter is provided, determine flow by measuring pump total dynamic head (TDH) and comparing to manufacturer pump curves.
8. If not all pumps engage simultaneously at design conditions, alternate which pumps are operating and validate system flow and ability to meet system differential pressure setpoint.

C. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves to approximate the maximum flow rate. Balance the flow rates for the terminals with open control valves.
3. Follow procedures outlined above for constant-flow hydronic systems.
4. Open all the control valves that were shut, and close enough control valves that were previously open to again approximate the maximum flow rate. Follow the procedures outlined above again.
5. The system differential pressure setpoint shall be the greater of the two measured values.

3.9 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Other Equipment with Fans: Plus or minus 5 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Hydronic Water Flow Rate: Plus or minus 5 percent.

3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into a separate section for each tested and balanced system. Provide a final report that is a complete record of the HVAC system performance, including conditions of operation, any outstanding items, and any deviations found during the testing and balancing process. The final report is to provide a reference of actual operating conditions for the owner and operations personnel. All measurements and test results that appear in the report must be made on site and dated by the responsible technician or test and balance engineer.
- B. As a minimum the report shall include the following information:
 1. Title page, including:
 - a. TAB company name, address, and telephone number.
 - b. Project name, client, identification number, and location.
 - c. Project architectural firm, address, and telephone number.
 - d. Project HVAC engineering firm, address, and telephone number.
 - e. Project HVAC contracting firm, address, and telephone number.
 - f. TAB certification statement.
 - g. Test and balance engineer name, signature, and certification number.
 - h. Report date.
 2. Table of contents.
 3. TAB national performance guarantee.
 4. Report summary, including:
 - a. List of items that do not meet specified tolerances.
 - b. Information that may be considered in resolving deficiencies.
 - c. For systems with automatic flow control valves:
 - 1) Measured flow control valve differential pressure for the first and critical automatic flow control valves.
 - 2) Measured pump flow at design conditions.
 5. Instrument list, including:
 - a. Type.
 - b. Manufacturer.
 - c. Model.
 - d. Serial number.
 - e. Calibration date.
 6. TAB test data for all systems included in the Work.

3.11 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 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat or temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance positions.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner's Representative.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner's Representative.
3. Owner's Representative shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to 10 percent of the total measurements recorded.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. 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 adjust. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's payment.

D. Prepare test and inspection reports.

3.12 SCHEDULE

A. Provide hydronic and air balancing for each of the following equipment items as part of this work. Note that listing an item of equipment includes any motors, valves, dampers, and filters associated with that equipment:

1. Control valves
2. Control dampers
3. Pumps
 - a. Heating water

ICI Warehouse Expansion Project

- b. Chilled water
- 4. Air terminal units
 - a. Fans
 - b. Coils
 - c. Control Dampers and Valves
 - d. Energy Recovery Devices
- 5. Air outlets and inlets
- 6. Power and Gravity ventilators
 - a. Exhaust fans
 - b. Pod exhaust fans
 - c. Louvered Penthouses
- 7. Kitchen hoods
- 8. Refrigerant condensing units
- 9. Chillers
- 10. Air-handling units
- 11. Packaged HVAC units
- 12. Ductless Split Systems
- 13. Fan coil units
- 14. Electric Unit heaters
- 15. Hydronic radiant heaters (Cabinet and Propeller)
- 16. Gas-fired radiant heaters

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes duct insulation and appurtenances.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Protection: Do not permit mineral fiber insulation to get wet. Mineral fiber insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Properties:
 - a. Maximum Operating Temperature: 180 deg F.
 - b. Minimum Operating Temperature: -70 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
 - d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
 - e. Maximum Water Absorption by Volume: 0.2%.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin in a flexible blanket. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.

- a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Atmosphere Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR Duct Wrap FRK.
2. Properties:
 - a. Maximum Operating Temperature: 250 deg F.
 - b. Maximum Compressed Thermal Conductivity at 75 deg F Mean Temperature:
 - 1) Density 0.75 PCF: 0.29 Btu-in/hr-ft²-deg F.
 - 2) Density 1.0 PCF: 0.27 Btu-in/hr-ft²-deg F.
 - 3) Density 1.5 PCF: 0.24 Btu-in/hr-ft²-deg F.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin in a semi-rigid board. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. CertainTeed Corp.; CertaPro Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Earthwool Insulation Board.
 - d. Manson Insulation Inc.; AK Board.
 - e. Owens Corning; Fiberglas 700 Series.
 2. Properties:
 - a. Maximum Operating Temperature: 450 deg F.
 - b. Minimum Operating Temperature: 0 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature:
 - 1) Density 3.0 PCF: 0.23 Btu-in/hr-ft²-deg F.
 - 2) Density 6.0 PCF: 0.23 Btu-in/hr-ft²-deg F.
 - d. Minimum Compressive Strength at 10% Deformation:
 - 1) Density 3.0 PCF: 25 lb/ft².
 - 2) Density 6.0 PCF: 200 lb/ft².

2.2 ADHESIVES

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

- B. For indoor applications, adhesives shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 2. Service Temperature Range: 0 to 180 deg F.
 - 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 4. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: 60 percent by volume and 66 percent by weight.
 - 4. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

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

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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

B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

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

2.6 FACTORY-APPLIED JACKETS

A. Insulation system specifications indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. All-Service Jacket (ASJ): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
2. All-Service Jacket – Self-Sealing Lap (ASJ-SSL): ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
3. Foil-Scrim Kraft (FSK) Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Maximum water vapor permeance 0.02 perms.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

2.8 FIELD-APPLIED CLOTHS

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

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
 - 1. Color: White unless indicated otherwise.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as indicated; roll stock ready for shop or field cutting and forming. Adhesive as recommended by jacket material manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Johns Manville; Ceel-Co or Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Color: White unless indicated otherwise.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
 - b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn].
 - 2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
 - b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
- E. Self-Adhesive Indoor or Outdoor Jacket: Multiple-ply laminated vapor barrier and waterproofing membrane for installation over insulation; consisting of aluminum, Tedlar, or laminate sheet with integral acrylic peel-and-stick adhesive with white, silver, or black facing as indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. 3M; VentureClad.
 - b. Polyguard Products, Inc.; Alumaguard 60.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation in accordance with manufacturers' instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- C. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system.
- D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Keep insulation materials dry during application and finishing. Mineral fiber insulation that is or has been wet shall be removed from the job site.
- 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 insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- N. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket or Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to all surfaces of ducts, fittings, and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center

- b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
- 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
- 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. For board insulation, groove and score insulation to fit to outside and inside radii of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center and at end joints.

3.8 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.

3.9 FINISHES

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

3.10 INDOOR DUCT INSULATION SCHEDULE

- A. Supply air, concealed from view, round or oval, duct insulation:
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

- B. Supply air, exposed to view in unfinished space, round or oval, duct insulation:
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- C. Supply air, exposed to view in finished space, round or oval, duct insulation:
1. Flexible Elastomeric: 1-1/2 inches thick with 20 mil PVC jacket.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density with 20 mil PVC jacket.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density with 20 mil PVC jacket.
- D. Supply air, concealed from view, rectangular, duct insulation:
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- E. Supply air, exposed to view in unfinished space, rectangular, duct insulation:
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
- F. Supply air, exposed to view in finished space, rectangular, duct insulation:
1. Flexible Elastomeric: 1-1/2 inches thick with 20 mil PVC jacket.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density with 20 mil PVC jacket.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density with 20 mil PVC jacket or finish-painted ASJ.
- G. Return air or mixed air, concealed from view, round or oval, duct insulation,
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- H. Return air or mixed air, exposed to view in unfinished space, round or oval, duct insulation,
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- I. Return air or mixed air, exposed to view in finished space, round or oval, duct insulation: None.
- J. Return air or mixed air, concealed from view, rectangular, duct insulation,
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- K. Return air or mixed air, exposed to view in unfinished space, rectangular, duct insulation,
1. Flexible Elastomeric: 1-1/2 inches thick.
 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
- L. Return air or mixed air, exposed to view in finished space, rectangular, duct insulation
1. Flexible Elastomeric: 1 inch thick with 20 mil PVC jacket.
 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density with 20 mil PVC jacket or finish-painted ASJ.
- M. Relief air or transfer air, any indoor location, duct insulation: None unless lined for acoustics.
- N. Outdoor air or combustion air, concealed from view, round or oval, duct insulation:
1. Flexible Elastomeric: 2 inches thick.
 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- O. Outdoor air or combustion air, exposed to view in unfinished space, round or oval, duct insulation:
1. Flexible Elastomeric: 2 inches thick.
 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- P. Outdoor air or combustion air, exposed to view in finished space, round or oval, duct insulation:
1. Flexible Elastomeric: 2 inches thick with 20 mil PVC jacket.
 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density with 20 mil PVC jacket.
 3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density with 20 mil PVC jacket.
- Q. Outdoor air or combustion air, concealed from view, rectangular, duct insulation:
1. Flexible Elastomeric: 2 inches thick.
 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- R. Outdoor air or combustion air, exposed to view in unfinished space, rectangular, duct insulation:
1. Flexible Elastomeric: 2 inches thick.
 2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
 3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- S. Outdoor air or combustion air, exposed to view in finished space, rectangular, duct insulation:
1. Flexible Elastomeric: 2 inches thick with 20 mil PVC jacket.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density with 20 mil PVC jacket.
3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density with 20 mil PVC jacket or finish-painted ASJ.

3.11 OUTDOOR DUCT INSULATION SCHEDULE

- A. Supply air, round or oval, duct insulation:
 1. Flexible Elastomeric: 2 inches thick.
- B. Supply air, rectangular, duct insulation:
 1. Flexible Elastomeric: 2 inches thick.
- C. Return air or mixed air, round or oval, duct insulation:
 1. Flexible Elastomeric: 2 inches thick.
- D. Return air or mixed air, rectangular, duct insulation:
 1. Flexible Elastomeric: 2 inches thick.
- E. Relief air or transfer air, any outdoor location, duct insulation: None.
- F. Outdoor air or combustion air, any outdoor location, duct insulation: None.
- G. Exhaust air (all classes), any outdoor location, duct insulation: None unless indicated otherwise.
- H. Exhaust air (class 2 exhaust from shower or washdown area), any outdoor location, duct insulation:
 1. Flexible Elastomeric: 2 inches thick.

END OF SECTION 23 07 13

SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal ducts and fittings.
2. Sheet metal materials.
3. Duct liner.
4. Rectangular duct connection systems.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Requirements

1. ANSI/SMACNA 006-2006 (SMACNA 006) HVAC Duct Construction Standards – Metal and Flexible Third Edition. All ductwork shall be in conformance with this standard.
2. Structural Performance: Duct hangers, supports, and seismic restraints (where applicable) shall withstand the effects of gravity, wind, and seismic loads and stresses within limits and under conditions described in SMACNA 006, ASCE/SEI 7, and local requirements.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.2 SYSTEM DESCRIPTION

- ##### A.
- Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the Architect/Engineer. Accompany requests for layout modifications with calculations showing the proposed layout will provide original design results without increasing system total pressure.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of the following products:
 - a. Prefabricated ductwork and fittings.
 - b. Liners and adhesives.
 - c. Rectangular duct connection systems.
 - d. Sealants and gaskets.
2. Shop Drawings:

- a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - b. Fittings, including details of construction.
 - c. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - d. Elevations of top and bottom of ducts along with applicable elevations of structural elements.
 - e. Dimensions of main duct runs from building grid lines.
 - f. Reinforcement and spacing.
 - g. Duct material and gauge thickness by pressure class.
 - h. Seam and joint construction.
 - i. Penetration details through fire-rated, smoke barriers and other rated partitions.
 - j. Equipment installation based on equipment being utilized on this project.
 - k. Duct accessories, including dampers, turning vanes, and duct access doors.
 - l. Length of application of acoustic duct liner where it will be applied.
 - m. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
 - n. Other systems installed in the same space as ducts where order of installation affects access.
 - o. Ceiling and wall mounted access doors and panels required to provide access to dampers, controls and other operating devices.
 - p. Ceiling mounted items, including light fixtures, diffusers, grilles, speakers, smoke detectors, sprinklers, other electrical devices, equipment and building structural members.
 - q. On each drawing, include a tabular list of each fan system's ductwork represented on that drawing and the total square foot surface area of each fan's duct system illustrated on the drawing.
 - r. Shop drawings shall be submitted prior to the fabrication or installation of the ductwork and serve as the foundation for coordination between various trades to maintain required ceiling heights.
3. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
- a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Failed test results and corrective action taken to achieve requirements.
- B. Leakage Testing Documentation: Contractor shall submit a written report to the authority having jurisdiction in which ducts designed at static pressures more than 3" wg pressure class have been leak tested and that the air leakage class is less than 6.0 per the Energy Code. Provide duplicate submittal to the Owner and the Engineer.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
- 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for steel hangers and supports.

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum hangers and supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance: Applicable requirements in:
1. NFPA 90A.
 2. NFPA 90B.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1.
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Damage: Handle, transport, and store ducts to avoid damage. Damaged ductwork is not acceptable.
- B. Protection: Protect ducts from mechanical damage, weather, and exposure to chemicals (including road salt). Do not permit insulation materials to get wet under any circumstances. Remove insulation that is or has been wet from the project site, and replace the insulation with undamaged new materials.
- C. Ductwork and associated components shall be stored on blocking in a clean dry area to prevent damage and to prevent the entrance of dirt, debris, foreign matter and moisture.
- D. Ductwork shall be adequately supported during storage to prevent sagging or bending.
- E. Provide temporary storage, delivery and handling in accordance with SMACNA Duct Cleanliness for New Construction Guidelines, Intermediate Level.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA 006 based on indicated static-pressure class. The figure numbers below reference that standard.
1. Transverse Joint: Figure 2-1.
 2. Longitudinal Seam: Figure 2-2.
 3. Pressure Class Gage and Reinforcement: Table 2-1 through Table 2-52 and Figure 2-3 through Figure 2-18.
 4. Elbow: Figure 4-2 (Use the following types only unless specifically approved by the Engineer.):
 - a. Type RE 1 (radius elbow).
 - b. Type RE 2 (square throat elbow with turning vanes).
 - c. Type RE 3 (radius elbow with vanes).

- d. Type RE 5 (dual radius elbow).
 - e. Type RE 6 (mitered elbow without turning vanes) only for angles not greater than 45 degrees.
- 5. Turning Vanes: Figures 4-3 and 4-4. Figure 4-9 short radius vanes in accordance with Chart 4-1 are acceptable.
- 6. Branch Connection:
 - a. Diverging Flow: Figure 4-5 (all types). Figure 4-6 (following types only):
 - 1) 45-degree entry to rectangular branch.
 - 2) 45-degree lead-in to round branch.
 - 3) Conical connection.
 - 4) Bellmouth connection.
 - 5) Conical or bellmouth spin-in fitting only for pressure class 2" WG or less.
 - b. Converging Flow: Figure 4-5 (all types) and Figure 4-6 (all types). Conical or bellmouth spin-in fitting is acceptable only for pressure class 2" WG or less.
- 7. Offset, Transition, or Obstruction: Figure 4-7 (all types) and Figure 4-8 (Figure B and C). Do not use Figure 4-8 Figure A (pipe through duct), Figure D (mitered offsets around obstruction, or Figure E (split duct around obstruction) unless specifically approved by the Engineer.

2.2 SINGLE-WALL ROUND OR FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA 006 Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Eastern Sheet Metal.
 - b. FlaktGroup SEMCO.
 - c. Lindab Inc.
 - d. McGill AirFlow LLC.
 - e. Sheet Metal Connectors, Inc.
 - 2. Transverse Joint: Figure 3-1 (all types).
 - 3. Longitudinal Seam: Figure 3-2 (all types). Do not use type RL-5 (grooved seam pipe lock or flat lock), RL-6 (snaplock), RL-7 (snaplock), or RL-8 (snaplock) seam for duct over 1" WG pressure class. Fabricate round duct larger than 90-inch diameter with butt-welded longitudinal seam.
 - 4. Pressure Class Gage and Reinforcement: Table 3-2 through Table 3-15 and Figure 3-3.
 - 5. Elbow: Figure 3-4. Use centerline radius of 1.5 diameters for each elbow unless space constraints prevent a radius that large; in that event, the radius may be reduced to that indicated in Table 3-1 with mitered segments. If space constraints prevent a radius as large as indicated in Table 3-1, a mitered elbow with turning vanes similar to Figure 4-3

and Figure 4-4 may be used. Do not use an adjustable elbow for duct over 1" WG pressure class.

6. Branch Connection with Diverging or Converging Flow: Figure 3-5 and Figure 3-6. All types are acceptable for pressure class 2" WG or less duct. For pressure class 3" WG or more duct, use 90-degree tee fitting with oval-to-round tap, 45-degree lateral fitting, conical fitting, or wye fitting. Reducers may be incorporated into the fitting. Use only factory-fabricated fittings, not saddles or field-fabricated taps, for pressure class 3" WG or more duct.
7. Offset, Transition, or Obstruction: Figure 4-7 and Figure 4-8 modified for round or flat oval duct. Do not use Figure 4-8 Figure A (pipe through duct), Figure D (mitered offsets around obstruction), or Figure E (split duct around obstruction) unless specifically approved by the Engineer.
8. Flat Oval: Figure 3-7 and applicable figures for equivalent round duct.

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA 006 for material thicknesses and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G90 unless otherwise indicated.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- D. Reinforcement Shapes and Plates:
 1. Steel Duct: ASTM A 36/A 36M, steel plates, shapes, and bars; black or galvanized.
 2. Aluminum Duct: ASTM B209 alloy 6061-T6 members or steel members isolated from the aluminum with butyl rubber, neoprene, or EPDM gasket materials.
 3. Other Duct Materials: Reinforcement materials compatible with the duct materials at contact points.
- E. Tie Rods: Materials compatible with duct materials. Galvanized steel or stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, and NAIMA AH124.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Owens Corning.

- b. CertainTeed Corporation: Insulation Group.
 - c. Johns Manville.
 - d. Knauf Insulation.
 - 2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy and registered by the EPA for use in HVAC systems.
 - 4. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 - 5. Water-Based Liner Adhesive: Comply with NFPA 90A and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC.
 - 2. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 3. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 - 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A. For indoor applications, adhesive with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch diameter shank, length to suit depth of insulation indicated with integral galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel, aluminum, or stainless steel (as appropriate); with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA 006 Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not install liner in rectangular ducts with longitudinal liner joints at locations other than corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Lined duct following unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are 2500 fpm or more.
 - d. Other locations as indicated.
 9. Terminate liner with buildouts (metal hat sections) at dampers, turning vane assemblies, or other devices. Secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 RECTANGULAR DUCT CONNECTION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Ductmate Industries, Inc.
 2. Hart & Cooley, Inc. Ward Industries.
 3. McGill Airflow LLC.

- B. Connection System: Rectangular duct transverse joint connection, reinforcement, and sealing system with roll-formed metal flanges, metal corner pieces, sealants, gaskets, and cleats.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a flame-spread index no greater than 25 and a smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.

- B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Sealant: Modified styrene acrylic.
3. Water resistant.
4. Mold and mildew resistant.
5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
6. Service: Indoor and outdoor.
7. Service Temperature: Minus 40 to plus 200 deg F.
8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
9. For indoor applications, sealant with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). For school projects, sealant complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

- D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

6. For indoor applications, sealant with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). For school projects, sealant complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts or other materials compatible with duct materials.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods; galvanized rods with threads painted with zinc-chromate primer after installation; or stainless steel all-thread rods and nuts.
- C. Strap and Rod Sizes: Comply with SMACNA 006 Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Cables:
 1. Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
 2. Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
 3. End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Structural shapes and plates of materials compatible with duct materials and environmental conditions. Support material shall match duct construction material.

2.8 CASINGS

- A. Fabricate casings according to SMACNA 1966 and construct for indicated operating pressures.
- B. Doors:

1. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles.
 2. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- C. Casings:
1. Fabricate acoustic casings with reinforcing turned inward.
 2. Furnish 18-gage back facing and front facing.
 3. Construct panels 3 inches thick and packed with 4.5-pcf minimum glass-fiber media, on 16-gage inverted channels.

2.9 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Cooper B-Line, Inc.; a division of Cooper Industries.
 2. Ductmate Industries, Inc.
 3. Hilti Corp.
 4. Kinetics Noise Control.
 5. Mason Industries.
 6. TOLCO; a brand of NIBCO INC.
 7. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized-steel or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION GENERAL REQUIREMENTS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply ducts (before air terminal units): 4-inch wg.
 - 2. Supply ducts (after terminal units): 2-inch wg.
 - 3. Supply ducts (inside shafts): 6-inch wg.
 - 4. Return and outside air ducts (in mechanical equipment rooms and inside shafts) (negative pressure): 4-inch wg.
 - 5. Return ducts (above ceiling): 2-inch wg.
 - 6. General exhaust ducts (negative pressure): 2-inch wg.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction losses for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings or Coordination Drawings.
- C. Install ducts according to SMACNA 006 unless otherwise indicated.
- D. Unless otherwise indicated, install ducts vertically plumb or horizontally level, and parallel and perpendicular to building lines. Avoid diagonal runs to maximum extent possible.
- E. Install ducts with a minimum clearance of 2 inch plus allowances for insulation thickness and access requirements.
- F. Cable hangers may only be used on low pressure (2" wg construction and lower) round spiral ductwork which is not insulated and has a diameter 10" or less. Utilize the double lock method such that the lower loop is clinched tight to the ductwork and the cable is vertical. Utilize manufacturer's top attachment device.
- G. Provide duct offsets needed to avoid interferences with structure, finishes, piping, other ducts, conduit, etc. Coordinate the work with all trades to minimize such offsets. Install ducts with fewest joints possible.
- H. Do not penetrate ducts with conduit or piping.
- I. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- J. Secure couplings with sheet metal screws. Install screws at maximum intervals of 12", with a minimum of 3 screws in each round metallic duct coupling.
- K. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections. Do not field-cut taps for branch connections in ducts with SMACNA pressure class magnitude more than 2 in wg.
- L. Install round or flat-oval ducts in maximum practical lengths to minimize joints.

- M. Do not install any duct in an electrical equipment room unless that duct serves that room.
- N. Do not install any duct in an elevator equipment room unless that duct serves that room.
- O. Do not install any duct over an electrical transformer, electrical switchgear, or an electrical panel unless approved in writing by the Engineer.
- P. Maintain clearances required in the National Electric Code for electrically-powered items.
- Q. Where ducts pass through interior partitions or exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal type and thickness as the duct. Overlap openings on all sides by at least 1-1/2 inches.
- R. Where ducts pass through fire-rated partitions, install fire dampers unless otherwise indicated. Comply with requirements in other Division 23 Sections for fire dampers.
- S. Where ducts pass through smoke partitions, install smoke dampers unless otherwise indicated. Comply with requirements in other Division 23 Sections for smoke dampers.
- T. Install ductwork takeoffs at smoke dampers such that there is a minimum of 24" between the damper and the start of the first takeoff.
- U. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts that are to be exposed in finished spaces from damage including dents, surface scratches, and markings. Exposed ducts must be undamaged and present a clean, neat appearance in materials and workmanship.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system in finished spaces.
- C. Grind welds to provide smooth surfaces free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets and inlets.
- E. Repair or replace ducts that do not comply with these requirements.

3.3 DUCT SEALING

- A. In accordance with ASHRAE 90.1, seal all ducts to SMACNA 006 seal class A with all transverse joints, longitudinal seams, and duct wall penetrations sealed. Seal openings for rotating shafts (including dampers) with bushings or other devices. However, do not seal an

opening if sealing the opening would void a manufacturer's listing. Spiral lock seams in round or flat oval ducts do not require sealing unless leakage is detected.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA 006 Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA 006 Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports. Other types of hangers may be used if so indicated or if approved by Engineer.
- E. Vertical Ducts: Support vertical ducts with steel angles or channel secured to the sides of the ducts with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Upper Attachments: Install upper attachments secured to structural members. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials. Do not attach duct supports to roof decks.
- G. Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, conduit, and piping

3.5 CONNECTIONS

- A. Make connections to motorized equipment with flexible connectors complying with other Division 23 Sections. Comply with SMACNA 006 for branch, outlet, inlet, and terminal unit connections.

3.6 CASINGS

- A. Floor Mounting:
 - 1. Install on 4 -INCH high concrete curbs as specified in Section 033000 - Cast-in-Place Concrete.
 - 2. At floor, rivet panels to angles 8 inches o.c.

3. If floors are acoustically insulated, provide liner of 18-gage supported 12 inches o.c. and turned up 12 inches sides with sheet metal shields

3.7 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems" or ASCE/SEI 7.
 1. Space lateral supports a maximum of 40 feet on center and longitudinal supports a maximum of 80 feet on center.
 2. Brace changes of direction longer than 12 feet (or less if local requirements indicate a shorter length).
- B. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent items.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to building structural members such as flanges of beams, upper truss chords of bar joists, or concrete members.
- G. Drilling for and Setting Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, conduit, and piping.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeves fully engaged in the structural elements to which anchors are to be fastened.
 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.8 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 primer compatible with the duct material.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test ductwork sections that have a design static pressure class magnitude of 4-inch wg or more regardless of duct locations. Test representative duct sections totaling no less than **25** percent of total installed duct area. Obtain Engineer's approval of specific sections to be tested beforehand.
 - 3. Test all ductwork located outdoors.
 - 4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 7. Give at least seven days notice for testing.
 - 8. Tests must demonstrate that tested ducts meet SMACNA leakage class 4 or less. If any tested section of ductwork fails to meet this requirement, perform the following at no additional cost to the Owner:
 - a. Leak test 100 percent of the ductwork in every duct system with any failed section.
 - b. Provide additional sealing of ductwork to eliminate excessive leakage in failed sections. If necessary, replace duct sections.
 - c. Retest 100 percent of the ductwork in every duct system with any failed section.
 - d. Continue sealing and retesting until the entire system is proven to meet the leakage requirement. Note that once a section is proven to meet the leakage requirement that section does not need to be tested again unless it is damaged later.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 DUCT CLEANING

- A. Clean duct system(s) before testing, adjusting, and balancing in accordance with other Division 23 Sections.

3.11 DUCT CONSTRUCTION REQUIREMENTS

- A. Fabricate ducts with materials, pressure classes, and insulations indicated on Drawings.

END OF SECTION 23 31 00

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Curtain-type fire dampers.
 - 3. Multiple-blade type fire dampers.
 - 4. Ceiling radiation dampers.
 - 5. Smoke dampers.
 - 6. Combination fire and smoke dampers.
 - 7. Flange connectors.
 - 8. Turning vanes.
 - 9. Duct-mounted access doors.
 - 10. Duct access panel assemblies.
 - 11. Flexible connectors.
 - 12. Duct accessory hardware.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.
 - a. For fire-dampers, smoke-dampers, combination fire- and smoke-dampers, and ceiling dampers include installation instructions.
 - b. For smoke-dampers and combination fire- and smoke-dampers include power, signal, and control wiring diagrams.
- B. Closeout Submittals:
 - 1. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- C. Maintenance Material Submittals:
 - 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 2. Fusible Links: Furnish quantity equal to at least 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA 006 for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or Type 316 as indicated. Unless indicated otherwise, No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. McGill Airflow LLC.
 - 5. Nailor Industries Inc.
 - 6. NCA.
 - 7. Pottorff.
 - 8. Safe Air – Dowco Products.
 - 9. Vent Products Co., Inc.
- B. Round Manual Volume Damper: Diameter 20 inches or less, air velocity 1500 fpm or less, and duct static pressure class 2-inch or less. Galvanized steel sleeve with reinforcing beads. Single

galvanized steel blade on axle with molded synthetic bearing at each end of axle and locking quadrant on standoff bracket. Basis of design Ruskin MDRS25.

- C. Round or Oval Manual Volume Damper: Diameter 48 inches or less, air velocity 4000 fpm or less, and duct static pressure class 10-inch or less. Galvanized steel construction for galvanized steel duct. Type 304 stainless steel construction for type 304 stainless steel or aluminum duct. Type 316 stainless steel construction for type 316 stainless steel duct. Rolled hat channel frame arranged for slip-in mounting. Single blade (or dual blades with center mullion for oval duct over 36 inches wide). Neoprene blade edge seals. Class II leakage rating. Blade mounted on axle with stainless steel sleeve bearing at each end of axle and locking quadrant on standoff bracket. Basis of design Ruskin CDR25 or CDO25.
- D. Rectangular Manual Volume Damper: Height 12 inches or less, air velocity 1500 fpm or less, and duct static pressure class 1-inch or less. Galvanized steel sleeve with blade stop. Single galvanized steel blade on axle with molded synthetic bearings and locking quadrant on standoff bracket. Basis of design Ruskin MD25.
- E. Rectangular Manual Volume Dampers: Height 5 inches or more, air velocity 1500 fpm or less., and duct static pressure class 3-inch or less. Galvanized steel hat channel frame with mitered and welded corners and blade stop. Flanged for attaching to wall and flangeless for installing in duct. Multiple single-thickness formed galvanized steel blades with opposed blade linkage enclosed in frame. Blades mounted on axles with molded synthetic bearings. Control shaft extended beyond frame with locking quadrant on standoff bracket. Basis of design Ruskin MD35.

2.4 CURTAIN-TYPE FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company DIBD series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. NCA.
 - 6. Pottorff.
 - 7. Safe Air – Dowco Products.
 - 8. Vent Products Co., Inc.
- B. Type: Static or dynamic as indicated on Drawings; rated and labeled according to UL 555.
- C. Fire Damper Dynamic Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated on Drawings.
- E. Mounting Orientation: Vertical or horizontal as indicated.

- F. Frame and Blade Material: Galvanized steel (or stainless steel for aluminum or stainless steel duct).
- G. Frame: Frame roll-formed in gages required by UL listing; with mitered and interlocking corners. Blade lock.
- H. Blades: Roll-formed interlocking curtain blades operated by fusible link and stainless-steel closure spring. Link temperature rating 165 or 212 deg F as indicated on Drawings.
- I. Mounting Sleeve: Factory-installed, galvanized steel in length required for installation. Steel mounting angles. Ends of sleeve act as duct collars for Style A or B. Integral duct collars at ends of sleeve for Style C, CR, or CO.

2.5 MULTIPLE-BLADE-TYPE FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company DFD60 series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. NCA.
 - 6. Pottorff.
 - 7. Safe Air – Dowco Products.
 - 8. Vent Products Co., Inc.
- B. Type: Dynamic; rated and labeled according to UL 555.
- C. Fire Damper Dynamic Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated.
- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Frame and Blade Material: Galvanized steel.
- G. Frame: Hat channel frame, minimum 16 gage, with mitered and interlocking corners.
- H. Blades: Single-piece airfoil blades equivalent to 14-gage strength, mounted on plated steel axles with permanently-lubricated stainless steel sleeve bearings pressed into frame. Parallel-blade-operation linkage concealed in frame.
- I. Fusible Link: Temperature rating 165 or 212 deg F as indicated on Drawings.
- J. Closure Spring: Stainless steel.

- K. Mounting Sleeve: Factory-installed, galvanized steel in length required for installation. Steel mounting angles. Ends of sleeve act as duct collars for Style A or B. Integral duct collars at ends of sleeve for Style C, CR, or CO.

2.6 CEILING RADIATION DAMPERS

- 1. Ruskin Company CFD series.
 - 2. American Warming and Ventilating.
 - 3. Nailor Industries Inc.
 - 4. NCA.
 - 5. Pottorff.
 - 6. Safe Air – Dowco Products.
- B. General Requirements:
- 1. Labeled according to UL 555C.
 - 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Heat-Responsive Device: Replaceable, 165 deg F or 212 deg F rated, fusible links.
- F. Fire Rating: 1, 2, or 3 hours as indicated.

2.7 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
- 1. Ruskin Company SD60 series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. NCA.
 - 6. Pottorff.
 - 7. Safe Air – Dowco Products.
- B. General Requirements: Label according to UL 555S.
- C. Damper Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Frame: Hat channel frame, minimum 16 gage, with mitered and interlocking corners.

- E. Blades: Single-piece airfoil blades equivalent to 14-gage strength, mounted on plated steel axles with permanently-lubricated stainless steel sleeve bearings pressed into frame. Parallel-blade-operation linkage concealed in frame.
- F. Seals: Flexible stainless steel compression jamb seals. Silicone blade edge seals mechanically fastened to blades; suitable for temperatures 450 deg F or less.
- G. Leakage: Class I.
- H. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; thickness to meet UL requirements.
- I. Damper Motors: Modulating or two-position action as indicated.
- J. Smoke Detector: Integral, factory wired for single-point connection.
- K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in other Division 23 Sections.
- L. Accessories:
 - 1. Auxiliary switches for position indication.
 - 2. Test and reset switches, damper or remote mounted as indicated.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company FSD60 series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. NCA.
 - 6. Pottorff.
 - 7. Safe Air – Dowco Products.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S.
- C. Damper Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated.
- E. Frame: Hat channel frame, minimum 16 gage, with mitered and interlocking corners.
- F. Blades: Single-piece airfoil blades equivalent to 14-gage strength, mounted on plated steel axles with permanently-lubricated stainless steel sleeve bearings pressed into frame. Parallel-blade-operation linkage concealed in frame.

- G. Seals: Flexible stainless steel compression jamb seals. Silicone blade edge seals mechanically fastened to blades; suitable for temperatures 450 deg F or less.
- H. Leakage: Class I.
- I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; thickness to meet UL requirements.
- J. Damper Motors: Modulating or two-position action as indicated.
- K. Smoke Detector: Integral, factory wired for single-point connection.
- L. Heat-Responsive Device: Resettable, 165 deg F or 212 deg F as indicated rated, fire-closure device and switch package, factory installed.
- M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in other Division 23 Sections.
- N. Master control panel for use in dynamic smoke-management systems.
- O. Accessories:
 - 1. Auxiliary switches for position indication.
 - 2. Test and reset switches, damper or remote mounted as indicated.

2.9 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ductmate Industries, Inc.
 - 2. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.10 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

- B. 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.
- C. General Requirements: Comply with SMACNA 006.
- D. Vane Construction: Single wall for vanes up to 48 inches wide and double wall for larger dimensions.

2.11 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA 006. Double wall, rectangular door. Galvanized sheet steel with insulation fill and thickness as indicated for duct pressure class. Butt or piano hinges and cam locks, quantities as indicated in SMACNA 006. Doors airtight and suitable for duct pressure class. Galvanized sheet steel frame with bend-over tabs and foam gaskets. Vision panel where indicated.
- B. Pressure Relief Access Door: Door and frame of galvanized sheet steel. Double wall door with insulation fill and metal thickness applicable for duct pressure class. Open outward for positive-pressure duct and inward for negative-pressure duct. Factory set at 3.0-inch to 8.0-inch wg positive or negative. Door retaining device. Neoprene or foam rubber seal.

2.12 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ductmate Industries, Inc.
 - 2. Approved equal.
- B. Labeled according to UL 1978. Double-wall panel with two layers of steel, minimum 11 gage (0.12-inch thick) carbon or 11 gage (0.13-inch) stainless, steel type to match duct material. Carbon or stainless steel panel fasteners welded to inner wall and attached by threaded fasteners to outer wall. Fasteners shall not penetrate duct wall. Gasket complying with NFPA 96; grease-tight and airtight, high-temperature ceramic fiber, rated for minimum 2000 deg F. Minimum pressure rating 10-inch wg, positive or negative.

2.13 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene. Minimum weight 26 oz./sq. yd. Minimum tensile strength 480 lbf/inch in the warp and 360 lbf/inch in the filling. Service temperature range minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone. Minimum weight 24 oz./sq. yd. Tensile strength 530 lbf/inch in the warp and 440 lbf/inch in the filling. Service temperature range minus 50 to plus 250 deg F.

2.14 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 in accordance with manufacturers' instructions.
- B. Install duct accessories according to applicable details in SMACNA 006 for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Compliance with ASHRAE/IESNA 90.1 restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft or control damper (as indicated) at inlet of exhaust fan or in exhaust duct close to exhaust fan unless otherwise indicated.
- E. Install volume dampers only in ducts constructed to magnitude 2" pressure class or less. Provide at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- F. Set each damper fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install fire or smoke damper according to UL listing.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coil.
 2. Upstream and downstream from duct filter.
 3. At outdoor-air intake and mixed-air plenum.
 4. At drain pan.
 5. Downstream from manual volume damper, control damper, backdraft damper, and equipment.
 6. Adjacent to and close enough to fire or smoke damper to reset or reinstall fusible link. Door for access to fire or smoke damper having fusible link shall be pressure relief access door and shall be outward operation for access door installed upstream from damper and inward operation for access door installed downstream from damper.
 7. Upstream and downstream from duct silencer.
 8. At each control device requiring inspection.
 9. Elsewhere as indicated.
- J. Install access door with swing against duct static pressure.
- K. Access Door Sizes:
1. One-Hand or Two-Hand Access: 12 by 12 inches.
 2. Head and Hand Access: 18 by 12 inches.
 3. Head and Shoulders Access: 24 by 18 inches.
 4. Body Access: 30 by 18 inches.
 5. Body plus Ladder Access: 30 by 30 inches.
 6. Where duct width does not permit door size specified above, one dimension of door size may be reduced to 2 inches less than duct width.
- L. Label access door as specified in another Division 23 Section to indicate the purpose of the access door.
- M. Install flexible connectors to connect ducts to equipment. If vibrating equipment is internally isolated from casing, provide rigid duct connections.
- N. For fan developing static pressure of 5-inch wg or more, cover flexible connector with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal unit to supply ductwork directly or with maximum 12-inch length of flexible duct. Do not use flexible duct to change directions or to correct misalignment of duct and terminal unit inlet.
- P. Connect diffuser or register to duct directly or with maximum 60-inch length of flexible duct clamped or strapped in place.
- Q. Connect flexible duct to metal duct with liquid adhesive plus tape.
- R. Install duct test hole where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:

ICI Warehouse Expansion Project

1. Operate each damper to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed and that door can open fully.
3. Operate fire, smoke, and combination fire and smoke damper to verify full range of movement and verify that proper heat-response or smoke-sensing device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operator to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 33 46 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulated flexible ducts.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
2. Shop Drawings: For flexible ducts. Include plans showing locations and mounting and attachment details.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA 006 "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with Air Diffusion Council "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
1. Flexmaster U.S.A., Inc.
 2. McGill Airflow LLC.
 3. Thermaflex; a Flex-Tek Group.
 4. Ward Industries; a brand of Hart & Cooley, Inc.

- B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-Value: R6.
- C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
- B. Non-Clamp Connectors: Liquid adhesive plus tape.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts according to applicable details in SMACNA006 for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions or correct misalignments.
- D. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with liquid adhesive plus tape or draw bands.
- F. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Centerline radius of bends of flexible ducting shall not be less than one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.

5. Install flexible ducts in a direct line, without sags, twists, or turns except as noted elsewhere.

G. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches on center.

END OF SECTION 23 33 46

SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal roof ventilators.

1.2 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevation.
- B. Operating Limits: Classify according to AMCA 99.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - a. Certified fan performance curves with system operating conditions indicated.
 - b. Certified fan sound-power ratings.
 - c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - d. Material thickness and finishes, including color charts.
 - e. Dampers, including housings, linkages, and operators.
 - f. Roof curbs.
2. Seismic Qualification Data: Certificates for indoor, basic air-handling units, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Informational Submittals:

1. Field quality-control reports.

C. Closeout Submittals:

1. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

D. Maintenance Material Submittals:

1. Belts: One spare set for each belt-driven unit.

1.4 QUALITY ASSURANCE

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

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

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. New York Blower Company.
4. PennBarry.
5. Twin City Fan & Blower.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Downblast Units: Provide spun-aluminum discharge baffle to direct discharge air downward.
2. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Direct Drive (Where Applicable): Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Belt Drives (Where Applicable):

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley. Spring-loaded idler pulley for automatic belt tensioning.
5. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or stainless steel wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base. Self-flashing without a cant strip configuration, with mounting flange.

1. Overall Height: 18 inches unless indicated otherwise.
2. Sloped Roof Mounting (Where Applicable): Manufacture curb for roof slope.
3. Burglar Bars: 1/2-inch-thick steel bars welded in place on 6-inch centers both directions.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors as indicated on Drawings and specified in another Division 23 Section. Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301. Factory test fans according to AMCA 300. Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210. Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans and accessories in accordance with manufacturer's instructions.
- B. Install power ventilators level and plumb.

- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. Coordinate roof curb installation with General Contractor.
- E. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 2 inches specified in another Division 23 Section.
- F. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension where applicable.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Provide and verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

END OF SECTION 23 34 23

SECTION 23 81 26 – DUCTLESS SPLIT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes single zone and multi-zone ductless split systems with matched variable speed condensing units.

1.2 DEFINITIONS

- A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.
- B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

1.3 SUBMITTALS

- A. Action Submittals:

- 1. Product Data: For each type of product include:

- a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.
- b. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- c. Operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
- d. Description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
- e. System operating sequence of operation in narrative form for each unique indoor-and outdoor-unit.
- f. Description of control software features.
- g. Total refrigerant required, and a comprehensive breakdown of refrigerant required by each system installed.
- h. Refrigerant type and data sheets showing compliance with requirements indicated.
- i. System design software information.
- j. Indication of location and type of service access.

- 2. Shop Drawings: For ductless split systems.

- a. Include plans, elevations, sections, and mounting attachment details.
- b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- c. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - d. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
 - e. Include diagrams for power, signal, and control wiring.
 - 3. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants. Include a sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.
- B. Informational Submittals:
- 1. Qualification Data:
 - a. For Installer: Certificate from ductless split system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation. Retain copies of Installer certificates on-site and make available on request.
 - b. For ductless split system manufacturer.
 - c. For ductless split system provider.
 - 2. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 3. Source quality-control reports.
 - 4. Field quality-control reports.
 - 5. Sample Warranties: For manufacturer's warranties.
- C. Closeout Submittals:
- 1. Operation and Maintenance Data: For ductless split systems to include in emergency, operation, and maintenance manuals.
 - 2. Software and Firmware Operational Documentation:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.

3. Extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Filters: One set for each unit.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of ductless split systems and products.
2. Shipped ductless split systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. Ductless split systems and products that have been successfully tested and in use in at least five completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. ISO Compliance: System equipment and components furnished by ductless split system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, ductless split system manufacturer.
2. Demonstrated experience on projects of similar complexity, scope, and value. Each person assigned to Project shall have demonstrated experience.
3. Service and maintenance staff assigned to support Project during warranty period.
4. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by ductless split system manufacturer.

1. Each Installer certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.

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. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

F. ASHRAE Compliance: Comply with applicable requirements in:

1. ASHRAE 15.
2. ASHRAE 62.1.
3. ASHRAE/IES 90.1.
4. ASHRAE 135: For control network protocol with remote communication.

- G. UL Compliance: Comply with UL 1995.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit. Remove and replace products that are wet, moisture damaged, or mold damaged.
- E. Replace installed products damaged during construction.
- F. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressors: Five (5) years from date of Substantial Completion.
 - b. For Parts, Including Controls: One (1) years from date of Substantial Completion.
 - c. For Labor: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Carrier / Toshiba
 - 2. Daikin AC (Americas), Inc.
 - 3. Lennox
 - 4. LG
 - 5. Trane / Mitsubishi Electric & Electronics USA, Inc.

6. Panasonic
7. Samsung.
8. York, a Johnson Controls company.
9. HAIER

2.2 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) ductless split system with variable capacity in response to varying cooling and heating loads. System shall consist of outdoor unit with single or multiple indoor units. Provide all piping, controls, and electrical power to make complete operating systems complying with requirements indicated.
 1. System operation, air-conditioning, or heat pump as indicated.
 2. Each system with one refrigerant to each indoor unit connected to system.

2.3 PERFORMANCE REQUIREMENTS

- A. System Design and Installation Requirements:
 1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
 2. Where manufacturer's requirements differ from requirements indicated, contact Engineer for direction. The most stringent requirements should apply unless otherwise directed in writing by Engineer.
- B. Isolation of Equipment: Provide isolation valves to isolate each indoor unit for service, removal, and replacement without interrupting system operation.
- C. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the range of not less than 50 percent to not more than 150 percent of outdoor-unit rated capacity or greater range if acceptable to system manufacturer.
- D. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.
- E. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
- F. Outdoor Conditions:
 1. Suitable for outdoor ambient conditions encountered.
 - a. Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.
 - b. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.
 2. Maximum System Operating Outdoor Temperature: See Drawings.

3. Minimum System Operating Outdoor Temperature: See Drawings.
 - G. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
 1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
 2. Outdoor: Within ordinance of governing authorities.
 - H. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.
- 2.4 INDOOR, EXPOSED, WALL-MOUNTED UNITS
- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
 - B. Cabinet:
 1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
 2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
 3. Mounting: Manufacturer-designed provisions for field installation.
 4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
 - C. DX Coil Assembly:
 1. Coil Casing: Aluminum, galvanized, or stainless steel.
 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 5. Unit Internal Tubing: Copper tubing with brazed joints.
 6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 7. Field Piping Connections: Manufacturer's standard.
 8. Factory Charge: Dehydrated air or nitrogen.
 9. Testing: Factory pressure tested and verified to be without leaks.
 - D. Drain Assembly:
 1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 2. Condensate Removal: Gravity. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
 3. Field Piping Connection: Non-ferrous material.
 - E. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
 5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
1. Access: Front, to accommodate filter replacement without the need for tools.
 2. Efficiency: ASHRAE 52.2, MERV 8.
 3. Media: Replaceable extended surface, panel, or cartridge with antimicrobial treatment fiber media.
- G. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.
- H. Unit Accessories:
1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
 2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
- I. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
 2. Factory-Installed Controller: Configurable digital control.
 3. Factory-Installed Sensors:
 - a. Unit inlet air temperature.
 - b. Coil entering refrigerant temperature.
 - c. Coil leaving refrigerant temperature.
 4. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay.
 - c. Auto-restart.
 - d. Auto operation mode.
 - e. Manual operation mode.
 - f. Filter service notification

- g. Power consumption display.
 - h. Drain assembly high water level safety shutdown and notification.
 - i. Run test switch.
 - 5. Communication: Network communication with other indoor units and outdoor unit(s).
 - 6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- J. Unit Electrical:
- 1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
 - 2. Field Connection: Single point connection to power entire unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in metal raceways.
- 2.5 INDOOR, RECESSED, CEILING-MOUNTED UNITS
- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
- 1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
 - 2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
 - 3. Mounting: Manufacturer-designed provisions for field installation.
 - 4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
- 1. Coil Casing: Aluminum, galvanized, or stainless steel.
 - 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 - 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 - 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 - 5. Internal Tubing: Copper tubing with brazed joints.
 - 6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 - 7. Field Piping Connections: Manufacturer's standard.
 - 8. Factory Charge: Dehydrated air or nitrogen.
 - 9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.
2. Efficiency: ASHRAE 52.2, MERV 8.
3. Media: Replaceable extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
 - a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
 - b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control to satisfy unit control sequence of operation indicated on Drawings.
2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

K. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
1. Factory-Installed Sensors:
 - a. Unit inlet air temperature.
 - b. Coil entering refrigerant temperature.
 - c. Coil leaving refrigerant temperature.
1. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay.
 - c. Auto-restart.
 - d. Auto operation mode.
 - e. Manual operation mode.
 - f. Filter service notification
 - g. Power consumption display.
 - h. Drain assembly high water level safety shutdown and notification.
 - i. Run test switch.
2. Communication: Network communication with other indoor units and outdoor unit(s).
3. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
4. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

L. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways.

2.6 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish. Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressors with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
 - a. High refrigerant pressure.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations.
 - f. Phase failure and phase reversal.
 - g. Short cycling.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.
 - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
2. Aluminum Microchannel Coils:
 - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.

- b. Single- or multiple-pass arrangement.
 - c. Construct fins, tubes, and header manifolds of aluminum alloy.
 - 3. Corrosion Protection: Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
 - 4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- E. Condenser Fan and Motor Assembly:
- 1. Fans: Propeller type.
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. Dynamically balanced.
 - 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 - 3. Motors: Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 - 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 - 5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
 - 6. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- G. Unit Controls:
- 1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 - 2. Factory-Installed Controller: Configurable digital control.
 - 3. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.
 - b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - f. Oil level.
 - 1. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay.
 - c. Auto-restart.
 - d. Fuse protection.
 - e. Auto operation mode.
 - f. Manual operation mode.

- g. Night setback control.
 - h. Power consumption display.
 - i. Run test switch.
 - j. Equalize run time between multiple similar components.
 - 2. Communication: Network communication with indoor units and other outdoor unit(s).
 - 3. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 4. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- H. Unit Electrical:
- 1. Enclosure: Metal suitable for unprotected outdoor locations.
 - 2. Field Connection: Single point connection to power entire unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in metal raceways.
- I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for 1000 hours according ASTM B 117.
- J. Unit Piping:
- 1. Unit Tubing: Copper tubing with brazed joints.
 - 2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 - 3. Field Piping Connections: Manufacturer's standard.
 - 4. Factory Charge: Dehydrated air or nitrogen.
 - 5. Testing: Factory pressure tested and verified to be without leaks.

2.7 SYSTEM CONTROLS

A. General Requirements:

- 1. Network: Indoor and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
- 2. Network Communication Protocol: Manufacturer's proprietary or open control communication between interconnected units. (Open protocol is strongly preferred.)
- 3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
 - a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.

- b. Integration devices shall be connected to local uninterruptible power supply units to provide at least 5 minutes of battery backup operation after a power loss.
 - c. Integration shall include control, monitoring, scheduling, and change of value notifications.
- 4. Operator Interface:
 - a. Operators shall interface with system and unit controls through the following:
 - 1) Operator interfaces integral to controllers.
 - 2) Owner-furnished PC connected to central controllers.
 - 3) Web interface through web browser software.
 - 4) Integration with Building Automation System.
 - b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:
 - 1) On/off control.
 - 2) Temperature set-point adjustment.

B. Wired Controllers for Indoor Units:

- 1. Single controller capable of controlling multiple indoor units as group.
- 2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
- 3. Temperature Units: Fahrenheit.
- 4. On/Off: Turns indoor unit on or off.
- 5. Hold: Hold operation settings until hold is released.
- 6. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
- 7. Temperature Display: 1-degree increments.
- 8. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between 45 and 90 degrees F.
- 9. Relative Humidity Display: 1 percent increments.
- 10. Relative Humidity Set-Point: Adjustable in 1 percent increments between 5 and 85 percent.
- 11. Fan Speed Setting: Select between available options furnished with the unit.
- 12. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
- 13. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
- 14. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
- 15. Occupancy detection.
- 16. Service Notification Display: "Filter".
- 17. Service Run Tests: Limit use by service personnel to troubleshoot operation.
- 18. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
- 19. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
- 20. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.

21. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

C. Wireless Controllers for Indoor Units:

1. Wireless Communication:
 - a. Controller communicates to remote-mounted receiver that is wired to indoor units.
 - 1) Include receivers with wireless controllers as required to complete installation.
 - 2) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.
 - b. One wireless controller capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.
2. Controller Battery Life: Minimum three years.
3. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
4. Temperature Units: Fahrenheit.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between 45 and 90 degrees F.
10. Relative Humidity Display: 1 percent increments.
11. Relative Humidity Set-Point: Adjustable in 1 percent increments between 5 and 85 percent.
12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Notification Display: "Filter".
18. Service Run Tests: Limit use by service personnel to troubleshoot operation.
19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
21. Setting stored in non-volatile memory to ensure that settings are not lost if power is lost. Battery for date and time only.

2.8 SYSTEM REFRIGERANT AND OIL

- A. Refrigerants for new heat pump and DX systems shall meet current federal phasedown requirements under the American Innovation and Manufacturing (AIM) Act and applicable state and local building code provisions for A2L refrigerants.

- B. Furnish refrigerants with a ****Global Warming Potential (GWP) $\leq$ 700**** for new HVAC equipment, in compliance with EPA regulations and the latest ASHRAE 34 safety classification.
- C. Refrigerants shall be ****classified A2L or better**** and shall be approved by UL/ANSI for the intended application (e.g., UL 60335-2-40, ASHRAE 15). Oil: As required by ductless split system manufacturer and to comply with performance requirements indicated.

2.9 SYSTEM REFRIGERANT PIPING

- A. Comply with requirements in other Division 23 Sections.
- B. Divided-Flow Specialty Fittings: Where required by ductless split system manufacturer for proper system operation, ductless split system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
- C. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Service Access:
 - 1. Maintain manufacturer's recommended clearances for service and maintenance.
 - 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations.
 - 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 - 4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.

- B. Equipment Restraint Installation: Install equipment with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 23.

3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Unless otherwise required by ductless split system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.
- C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
- D. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
- E. In rooms without ceilings, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
- F. Provide lateral bracing if needed to limit movement of suspended units.
- G. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
- H. Install floor-mounted units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
- I. Attachment: Install hardware for proper attachment to supported equipment.
- J. Place grout under equipment supports and make bearing surface smooth.

3.4 INSTALLATION OF OUTDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Install outdoor units on support structures indicated on Drawings.
- C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
 - 1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 2. Grouting: Place grout under equipment supports and make bearing surface smooth.
- D. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Division 07. Anchor units to supports with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved.
- B. Where installing piping and tubing adjacent to equipment, allow space for service and maintenance.
- C. Install piping and tubing in concealed locations unless otherwise indicated except in equipment rooms and service areas.
- D. Conform to Division 23 piping specifications.

3.6 ELECTRICAL INSTALLATION

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. Comply with Division 26 for wiring, grounding, and bonding connections.

3.7 INSTALLATION OF SYSTEM CONTROL CABLE

- A. Conform to Division 23 and 28 requirements.

3.8 IDENTIFICATION

- A. Identify system equipment. Comply with requirements for identification specified in Division 23.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage ductless split system manufacturer's service representative to perform manufacturer's recommended testing and to observe and inspect components, assemblies, and equipment installations, including controls and connections.
- B. Products will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 STARTUP SERVICE

- A. Engage a manufacturer's service representative to perform systems startup service.
 - 1. Service representative shall be an employee or a factory-trained and -authorized service representative of the ductless split system manufacturer.
 - 2. Complete startup service of each separate system.

3. Complete system startup service according to manufacturer's written instructions.
- B. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service. Installer shall correct deficiencies found during startup service for reverification.
- C. System Operation Report:
 1. After completion of startup service, manufacturer shall issue a report for each separate system.
 2. Report shall include documentation describing each startup check, the result, and any corrective action required.
 3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference. All available system operating parameters shall be included in the information submitted.

3.11 ADJUSTING

- A. Adjust equipment and components to function in accordance with manufacturer's recommendations.
- B. Lubricate equipment as recommended by manufacturer.
- C. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- D. Set field-adjustable switches and circuit-breaker trip ranges according to ductless split system manufacturer's written instructions, and as indicated.
- E. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.12 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of system Installer. Include four service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software. Provide upgrade notice at least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.14 DEMONSTRATION

- A. Engage a manufacturer's employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- B. Location: Owner shall provide a suitable on-site location to host classroom training.
- C. Training Materials: Provide training materials in electronic format to each attendee.
 - 1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- D. Acceptance: Obtain written acceptance from Owner's representative that training is complete, and requirements indicated have been satisfied.

END OF SECTION 23 81 26

SECTION 26 05 01 – GENERAL PROVISIONS

PART 1 **GENERAL**

1.01 **SUMMARY OF WORK**

- A. The requirements of the General Conditions, General Requirements, Special Conditions, Instructions to Bidders, Contract Documents and other information bound herewith form a part of and shall govern all work performed under these specifications.
- B. The accompanying electrical drawings are issued as part of this project manual. Any specifications requirements shown on the drawings are equally affective as if included herein. Any omissions of specification are not to be a basis for failure on the part of the Contractor, from installing electrical components required by the systems to operate in the intended manner.
- C. The drawings depict the systems' components and distribution method. Every attempt is made to complete the distribution, however discrepancies may develop in the process. The contractor, within reason, is required to prepare his bid and construction to develop complete and operable systems. (This includes obvious omitted conduit and wire to equipment and fixture connections). In the event of discrepancies in sizes from drawing to drawing, the contractor shall include the cost for the larger size.
- D. Should any work be called for on the drawings, specifications or in the codes, in such a manner that the Contractor cannot, in his judgment, comply with the requirements, then the Contractor shall bring the matter to the attention of the Engineer before proceeding with the work.
- E. The Contractor shall receive, unload, store, protect and install all electrical equipment whether supplied by the Contractor or by the other trades. Equipment furnished by others and received prior to the start of work by the Contractor will be unloaded and stored by others. During the progress of the work, the Contractor shall load and transport such material and equipment to the job site as required. The Contractor shall keep all stored materials clean and protected from the weather.
- F. The Contractor shall be responsible for complete assembly and wiring of all equipment which is purchased disassembled or disassembled for shipping purposes.
- G. Work includes the installation of equipment, conduit and wire and components for complete and operable systems.
- H. Should a coordination study be called for on the drawings, specifications or in the codes, the Contractor shall provide the coordination study and bear the cost to make required changes to the electrical systems to achieve coordination.

1.02 DEFINITIONS AND TERMS USED IN THE DIVISION 26 SPECIFICATIONS AND ELECTRICAL DRAWINGS

- A. The word "Owner" shall mean the party mentioned in the prime contract agreement, or any representative of his party duly authorized to act in his behalf in the execution of the work.
- B. The word "Construction Manager" shall mean the person, firm or corporation entering into a contract with the Owner to manage construction operations.
- C. The word "Contractor" shall mean the person, firm or corporation entering into a contract to construct and complete the work as specified herein.
- D. The word "Engineer" shall mean NEO Engineers and their representatives assigned to this project.
- E. The word "Architect" shall mean Studio View Architecture and their representative acting as the Owner's appointed agent.
- F. The words "Commissioning Agent or Engineer" shall mean the Owner's Agent and their representatives, hired to commission or verify performance of all or portions of the work included in the contract documents.
- G. The word "furnish" or "supply" shall mean to purchase and deliver to project site, ready for unloading, unpacking, assembly, installation and similar subsequent requirements.
- H. The word "install" shall mean operations at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar requirements.
- I. The word "provide" shall mean to furnish and install complete and ready for intended use.

1.03 CODES, FEES AND MISCELLANEOUS COSTS

- A. All materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards and utility company regulations.
- B. In cases of difference between building codes, specifications, state laws, local ordinances, industry standards and utility company regulations and the Contract Documents, the most stringent shall govern. The Contractor shall promptly notify the Engineer in writing of any such differences.
- C. Non-Compliance: Should the Contractor perform any work that does not comply with requirements of applicable building codes, state laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising for correction of non-complying items.
- D. Applicable Codes and Standards shall include all state laws, local ordinances, utility company regulations and applicable requirements of following nationally accepted codes and standards. These requirements are to be considered minimum and are to be exceeded when so indicated on the drawings or herein specified.

1. Governing Agencies
 - a. Fire Prevention and Building Safety Commission
 - b. Indiana Department of Health
2. Applicable Codes
 - a. Indiana Building Code (IBC), 2014, consisting of:
 - (1) International Building Code, 2012
 - (2) Indiana Amendments
 - b. Indiana Electrical Code (IEC), 2009, consisting of:
 - (1) NFPA 70, National Electrical Code, 2008
 - (2) Indiana Amendments
 - c. Indiana Mechanical Code (IMC) 2014 consisting of:
 - (1) International Mechanical Code 2012
 - (2) Indiana Amendments
 - d. Indiana Plumbing Code (IPC), 2012 Edition consisting of:
 - (1) International Plumbing Code, Second Printing
 - (2) Indiana Amendments
 - e. Indiana Energy Conservation Code (IECC) 2010, consisting of:
 - (1) American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. Standard 90.1, 2007 Edition
 - (2) Indiana Amendments
 - f. Indiana Fire Code (IFC), 2014, consisting of:
 - (1) International Fire Code, 2012
 - (2) Indiana Amendments
3. Standards
 - a. ASTM: American Society of Testing Materials
 - b. ANSI: American National Standards Institute
 - c. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
 - d. NEC: National Electric Code
 - e. NECA: National Electrical Contractors Association
 - f. NEIS: National Electrical Installation Standards
 - g. NEMA: National Electrical Manufacturers Association
 - h. NFPA: National Fire Protection Association
 - i. OSHA: Occupational Safety and Health Act
 - j. UL: Underwriters Laboratories
 - k. ADAAG: Americans with Disabilities Act Accessibility Guidelines
 - l. NFPA 101: Life Safety Code
 - m. ASCI: American Standard Code for Information Exchange
 - n. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. - 90.1 – 2013

- o. EIA: Electronic Industry Testing Standards
- p. FM: Factory Mutual
- q. IES: Illuminating Engineering Society of North America Tenth Edition Handbook and associated Recommended Practice documents

- E. The Contractor shall be responsible for obtaining all permits, payment of all fees, necessary drawings and arranging and paying for all inspections, tests, etc. which may be required by any governing authority or utility company in connection with the furnishing or installation of any of his work.

1.04

WORK AND WORKMANSHIP

- A. All materials and equipment shall be of the highest quality in every respect. All materials and equipment shall be new and of the latest design and free of defects.
- B. Workmanship shall be by skilled workmen of highest standard in strict accordance with all applicable manufacturers' printed specification (which, by reference, are made completely a part of these specifications as though herein repeated), performed under supervision of competent foremen at all times.
- C. The Owner has full power to condemn or reject any work, materials or equipment not in accordance with these specifications and construction drawings or are not in compliance with the manufacturers' specifications or drawings which were approved by the Owner or Engineer.
- D. Work or equipment that is rejected shall be removed and replaced to the satisfaction of the Owner, at the Contractor's expense. Work or equipment that is rejected shall be so stated in writing by the Owner or Engineer.
- E. Such decisions that the Owner or Engineer may make with respect to questions concerning the quality, fitness of materials, equipment and workmanship shall be binding upon the parties thereto.
- F. Special attention shall be given to accessibility of working parts and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.

1.05

DEVIATIONS FROM DRAWINGS

- A. Electrical drawings show the intended arrangement of all equipment and appurtenances. They shall be followed as closely as actual building construction and work of other trades will permit.
- B. The Contractor shall investigate structural and finish conditions affecting his work and shall coordinate his work accordingly. Provide any such fittings, offsets and accessories which may be required by such conditions.
- C. The Contractor shall coordinate with other trades and provide any fittings, offsets and accessories required to obtain the coordinated installation, in addition adjustment shall be made for reasons to improve the installation or performance, etc., made upon receiving the approval of the Engineer. The Contractor shall document that adjustments have been coordinated with all parties concerned.

1.06 OCCUPATIONAL SAFETY AND HEALTH ACT

All work shall comply with the current requirements of the U.S. Department of Labor Occupational Safety and Health Administration, entitled Occupational Safety and Health Standards; National Consensus Standards and Established Federal Standards.

1.07 COORDINATION BETWEEN CONTRACTORS

- A. The Contractor and his Subcontractors shall study all drawings and specifications for this project so that complete coordination between trades will be effected. Special attention shall be given to points where conduits cross ducts, piping or telephone cables, where lights fit into ceilings and where conduits pass through walls and structural elements.
- B. It is the responsibility of the Contractor and his Subcontractors to leave necessary room for other trades. No extra compensation will be allowed to cover the cost of removing conduits, or equipment found encroaching on space required by others.
- C. The Contractor shall review the electrical requirements of the final equipment selections to ensure such items receive proper electrical services or connections.
- D. The Contractor shall provide complete information and cooperation to the other Contractors and trades pertaining to his work to accomplish coordination of the complete project.
- E. The Contractor shall coordinate with the General Contractor in providing the necessary sleeved openings, excavations, etc. Cutting and patching shall be held to a minimum.
- F. The Contractor and his Subcontractor shall be required to attend the periodic progress meetings to accomplish coordination with the Owner, Architect and Engineer.
- G. After contract award the Engineer may provide AutoCAD electronic files of the floor plan(s) provided the successful contractors sign a Release Form. The Engineer will not provide Revit electronic files to contractors. The Engineer will not participate in Building Information Modeling (BIM) coordination with contractors.
- H.

1.08 MECHANICAL SYSTEMS STARTUP

The Electrical Contractor shall attend pre-startup meetings and shall be present at each mechanical system startup.

1.09 INSPECTION

At the appropriate intervals of the electrical installation, the Contractor shall inform the local and state authorities to arrange inspections of this work. Provide Certificates of Inspection when completed.

1.10 REPORTS AND FINAL SUBMISSIONS

- A. The Contractor shall submit, for attachment to the Substantial Completion Certificate, a letter certifying that the electrical system wiring is in accordance with the latest adopted edition of The National Electrical Code.
- B. Submit all other test reports, as hereinafter specified.

1.11 COORDINATION WITH COMMISSIONING

- A. The purpose of the commissioning process is to provide the Owner of the facility with a high level of assurance that the mechanical and electrical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Construction Documents.
- B. Each trade contractor shall review the procedures in the specification sections and include the necessary cooperation and coordination.

PART 2 **PRODUCTS**

2.01 PRODUCT AND MATERIAL APPROVAL

- A. When Manufacturer's model numbers are listed they are for reference only and are not to be considered a basis of design. The model numbers listed are the best information made available to the designer by the manufacturer and not intended to supplant or be inclusive of the criteria defined in the specifications and drawings. The Contractor/Manufacturer shall review the complete construction documents to assure the products proposed are appropriate and meet the system design criteria.
- B. The performance requirements listed in the specifications or shown on the drawings are the basis of design and will be the benchmark used for submittal review and approval as well as determining if work is accepted or rejected.
- C. A specification followed by one or more manufacturers is limited to those manufacturers. Names of other proposed manufacturers may be submitted for approval to the Engineer a minimum of ten (10) days prior to receiving bids. Approval will be granted only if issued by Addendum (no exceptions).
- D. A specification followed by one or more manufacturers and "or approved equal" is open to equal products or materials. However, the Contractor shall supply one of the listed manufacturers at no additional cost if Engineer determines substituted product unsatisfactory.
- E. Any substituted equipment offered for consideration shall be stated as a separate item with the bid. State any additive or deductive cost.
- F. If changes in conduit, wiring, equipment layout or electrical service are brought about by the use of equipment which is not compatible with the layout shown on the drawings, the Contractor shall include the cost of the necessary changes in his bid.

2.02 SUBCONTRACTORS AND MATERIAL LIST

- A. The Contractor shall submit, with their bid, a fully completed list of subcontractors, manufacturers and suppliers of each item listed. No substitutions will be allowed, by the Contractor, after award of contract.
- B. Failure to submit a fully completed list within the stated time may be cause to reject the bid.
- C. Remove or copy the following list and attach it to the bid form.

2.03 LIST FOR ELECTRICAL CONTRACTOR

- A. The Contractor

<u>Sub-Contractors</u>	<u>SUBCONTRACTORS AND MATERIALS</u>
Fire Alarm Subcontractors	_____
Thermographic Surveys Subcontractors	_____
Trench/Backfill/Compact Subcontractors	_____
Testing Subcontractors	_____

- B. Material and Suppliers List

<u>SECTION</u>		<u>MANUFACTURER</u>	<u>SUPPLIER</u>
26 05 26	Ground Rods	_____	_____
26 05 33	Sleeves	_____	_____
26 05 33	Conduit	_____	_____
26 05 33	Outlet and Junction Boxes	_____	_____
26 22 13	Dry Type Transformers	_____	_____
26 24 15	Switchboards	_____	_____
26 24 16	Panelboards	_____	_____
26 27 17	Manholes	_____	_____
26 27 17	Handholes	_____	_____
26 27 26	Wiring Devices	_____	_____
26 27 27	Floor Boxes	_____	_____
26 28 00	Overcurrent Protection	_____	_____
26 29 00	Motor Starters	_____	_____
26 29 00	Safety Switches	_____	_____
26 43 13	Surge Protective Devices (TVSS)	_____	_____
26 51 00	Light Fixtures Type '____'	_____	_____
27 05 28	Telephone System	_____	_____
28 31 00	Fire Detection System	_____	_____

2.04 EQUIPMENT DELIVERY SCHEDULE

- A. Submit at Engineer's request a schedule listing equipment and materials for complete installation, quantity ordered, date of placing order and the promised delivery dates.
- B. Any and all probable delivery delays shall be identified at the pre-construction meeting.

2.05 SUBMITTALS

- A. The Contractor shall submit shop drawings, fabrication drawings, and specific product literature for all products specified and shown on the drawings.
- B. Approval of submittals does not relieve the Contractor of the responsibility for ordering proper quantities and miscellaneous appurtenances required for operation and/or installation of the respective material or equipment.
- C. The following general information is required with each submittal as applicable:
 - 1. Contractor's stamp, signature and data shall be affixed to the submittal with indication of his review and approval.
 - 2. The full manufacturer's model number of each item
 - 3. Identification of each item's performance, physical size and construction data.
 - 4. Identification of finishes. Furnish two (2) color chips for items requiring color/finish selections.
 - 5. Indicate any modifications made to manufacturer's standard design which were required by these specifications.
 - 6. Rough-in, foundation and support point dimensions.
 - 7. Complete wiring diagrams and connection identifications, specific to this project.
- D. In addition, submit any detailed or specific information as stated in the respective specification sections.

2.06 SUBMITTALS

- A. The Contractor shall submit record drawings as stated in the General Conditions, and as specified herein.
- B. During construction, maintain a complete and legible set of drawings, at job site showing changes and deviations between actual construction and Engineer's drawings. Submit marked-up set to Engineer for review at each project meeting.
- C. Submit to Engineer for review at the 25%, 50%, 75% and 100% completion of the work a complete, accurate and neat set of mark-ups blue-line drawings showing the complete "record drawings" construction.
- D. This marked-up set shall be returned to the Contractor as many times as necessary in order to obtain desired results.

2.07 MAINTENANCE MANUALS

- A. The Electrical Contractor shall submit maintenance manuals as stated in the General Conditions and as described in further detail herein.
- B. Maintenance Manuals are to include all information relative to maintenance and operating instructions for all new electrical equipment including equipment furnished by Owner and installed by Electrical Contractor.

- C. Maintenance manuals shall be assembled in the following sections:
 - 1. Section 1
 - a. Title of project
 - b. Name and address of Owner, Contractor and Engineer
 - c. Completion date of project
 - 2. Section 2: Index of complete contents
 - 3. Section 3:
 - a. Listing of all equipment with model number, serial number.
 - b. Warranty of each piece of equipment with start and completion dates.
 - 4. Sections 4 thru ____ (as applicable for each piece of equipment)
 - a. Drawings or data sheets on each piece of equipment which was submitted for approval.
 - b. Installation instructions.
 - c. Operating instructions
 - d. Maintenance manuals and parts list
- D. Each section shall be separated by a pasteboard tabbed divider. Each section tab shall identify equipment by same name as listed in the index. Tabs shall extend outside of sheet size.
- E. All information shall be arranged in as many three-ring (3" D configuration) vinyl coated notebooks as necessary. Do not overload capacity of binder.

PART 3

EXECUTION

3.01

PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle equipment and components carefully to prevent damaging, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.
- B. Store equipment and components in clean dry place. Protect from weather, theft, dirt, fumes, water, construction debris and physical damage at all times.

END OF SECTION

SECTION 26 05 02 – ASSIGNMENTS OF MISCELLANEOUS WORK

PART 1 **GENERAL**

1.01 **PAINTING**

- A. Painting of exposed electrical system in public areas shall be by General Contractor.
- B. Painting of electrical work in mechanical equipment and fan rooms (color coded) shall be by Electrical Contractor in accordance with Specification Section 26 05 64, Painting.
- C. Painting of all interior and exterior, non-galvanized, metal supports, stands and miscellaneous metal for electrical equipment shall be by the Electrical Contractor in accordance with Specifications Section 26 05 64, Painting.

1.02 **WALL OPENINGS**

- A. Wall openings for electrical work not noted on the Architectural or Structural drawings shall be arranged for and provided by the Electrical Contractor.
- B. Lintels for wall openings required by electrical work will be furnished and installed by the Contractor constructing the wall. Electrical Contractor is responsible for notifying that Contractor of locations and sizes of openings requiring lintels prior to wall construction. Openings not coordinated and provided shall be arranged for and provided by the Electrical Contractor.
- C. Final sizes and locations of electrical penetrations in walls are the responsibility of the Electrical Contractor.
- D. Provide approved fire stops for fire rated wall and floor openings.
- E. Common room walls with electrical outlets, shall include fire putty pads to maintain fire rating of wall.

1.03 **ROOF AND FLOOR OPENINGS**

- A. Roof and floor openings for electrical work shall be provided by Electrical Contractor. Miscellaneous framing required and cutting of openings, shall be furnished and installed by the contractors constructing the roof or floor structure. Electrical Contractor is responsible for notifying those Contractors of exact locations and sizes prior to construction of the framing. Openings not coordinated and provided shall be arranged and paid for by the Electrical Contractor.
- B. Final sizes and locations of electrical penetrations through the roof and floor structures are the responsibility of the Electrical Contractor requiring the opening.
- C. Roof curbs and supports for electrical penetrations shall be provided by the Electrical Contractor requiring same.
- D. Counterflashing shall be provided by the Electrical Contractor. Roof flashing shall be provided by the roofing contractor.
- E. All roofing work required on the existing building (openings, flashing, etc.) shall be performed by the Roofing Contractor maintaining the warranty.

- F. Provide fire retardant plywood sheets when roof areas are completed during operations for walkways and work areas. The Contractors working on the completed new roof shall be responsible for roof protection and assuring the warranty on the roof system is maintained.

1.04 WALL AND CEILING ACCESS PANELS

- A. Wall and ceiling access panels shall be furnished by the Electrical Contractor.
- B. Electrical Contractor is responsible for coordinating and assisting in locating all access panels, for installation by the General Contractor prior to his wall or ceiling construction. to obtain access to equipment, junction boxes, etc.
- C. Access panels shall be required for all controls or other components requiring periodic maintenance. Panels shall be located to be accessible without causing damage to final finishes. Coordinate items requiring access including with other trades so that the quantity of access panels is kept to a minimum.
- D. The panel locations shall also be coordinated with, and receive the approval of, the Architect and Engineer.
- E. Access Panels shall be as specified in Section 08 31 13.

1.05 CUTTING AND PATCHING

- A. Cutting and patching of finished areas for electrical work shall be provided by the General Contractor. Electrical Subcontractors shall coordinate responsibility for cutting and patching with Electrical Contractor prior to bidding.
- B. Cutting and patching of finished areas shall be provided by the Contractor requiring same, however, the work shall be performed by the trade responsible for this type of work.
- C. Patched surfaces shall be finished to match existing unless the surface is scheduled for that type of work.

1.06 CONCRETE PADS

- A. Concrete pads for electrical equipment shall be provided by Electrical Contractor in accordance with Specifications Section 26 05 05, Concrete Pads and Curbs.
- B. Concrete pad removals and floor patching by Electrical Contractor.

PART 2 **PRODUCTS**

NOT USED.

PART 3 **EXECUTION**

3.01 PLATFORMS AND SUPPORT STANDS

- A. Platforms and supporting stands shall be provided by the Electrical Contractor for their respective equipment.

- B. Each piece of equipment or apparatus suspended from ceiling or mounted above floor level shall be provided with suitable structural support, platform or carrier constructed in accordance with best recognized practice in a neat and workmanlike manner.
- C. Contractors shall exercise extreme care that structural members of building are not overloaded by such equipment. In all cases, details of such hangers, platforms and supports together with total weights of mounted equipment shall be approved by Structural Engineer.
- D. Support raceways on accepted types of wall brackets, specialty steel clips or hangers, ceiling trapeze hangers or malleable iron straps. Plumber's perforated straps are not permitted. Acceptable manufacturers' bracket or hangers are "Kindorf", "Elcan", "Blinkley", "Multi-Frame", "Power-Strut" or "Unistrut". Do not suspend raceways or equipment from steam, water or other piping or ductwork, and/or pre-stated system supports, except as otherwise permitted. Provide independent and secure support methods.
- E. Provide all structural supports for the proper attachment of electrical equipment supplied and also for equipment such as motor controllers, supplied under other sections or by Owner for mounting connection and installation under this section.

3.02 ATTACHING TO BUILDING CONSTRUCTION

- A. Equipment and conduit supports shall be attached to structural members (beams, joists, etc.) rather than to floor or roof slabs.
- B. Support equipment suspended from structure by adjustable threaded steel rods of adequate diameter and strength anchored to the floor arch of the structural steel. Support auxiliary steel, if required, from the building steel. Secure no hangers to furred ceilings or ductwork.
- C. Where equipment is suspended from existing concrete or masonry construction, use expansion shields to attach supports to construction. Expansion shield bolt diameter shall be the same size as support rod diameter, hereinafter specified.
- D. Where existing masonry is not suitable to receive and hold expansion shields or where other means of attachment is advantageous, Contractor shall submit alternate method for approval of Architect and/or Engineer.
- E. Raceways or light fixtures shall not be suspended from ceiling suspension system. The Electrical Contractor shall be responsible for providing adequate support for raceways or fixtures. All supports shall be secured to a structural member of the facility.
- F. Mount wall-mounted equipment directly to wall by means of steel bolts. Maintain at least 1/4-inch air space between equipment and supporting wall. Mount groups or arrays of equipment on adequately sized steel channels, such as those manufactured by Kindorf and Unistrut.
- G. Secure equipment and steel to solid masonry by means of screw and bolt anchors and expansion bolts. On structural steel use clamps, approved by the Engineer, which do not depend primarily on set-screw pressure for security.

- H. Where supports are attached to structural members coated with fireproofing, the Contractor shall clean the fireproofing, attach the support and patch the fireproofing with like material.

3.03 ELECTRICAL CONNECTIONS TO EQUIPMENT

- A. In the event that equipment furnished by other Contractors or Subcontractors requires a larger motor starter, disconnect, or feeder circuit (conduit, wire, and necessary appurtenances), than that which is indicated on the documents, the Contractor supplying said equipment is responsible to reimburse the Electrical Contractor for supplying the larger starter, disconnect for the difference in labor and material cost.
- B. Connections and wiring diagrams shown on the drawings or described in the specifications are general and are for bidding purposes only. Detailed diagrams and instructions shall be provided by Contractor supplying equipment. Contractor shall notify the Electrical Contractor prior to start of his related work.
- C. Relays, switches, contactors, etc. which may be required in addition to those specified for and indicated on the electrical drawings shall be provided by Mechanical Contractor for installation by the Electrical Contractor. These devices shall be mounted by the Electrical Contractor at the apparatus to be installed and the Mechanical Contractor supplying these additional devices shall reimburse the Electrical Contractor for his labor and material costs. Electrical Contractor shall provide all additional conduit, wire and electrical connections without additional charge to the Owner.
- D. In event that several pieces of mechanical equipment from different suppliers are combined into one system, Mechanical Contractor shall furnish complete wiring and control diagram to enable Electrical Contractor to make proper connection. Diagrams shall be submitted to Engineer for approval prior to actual wiring.
- E. Mechanical Contractor shall furnish to Electrical Contractor written notice of approval and acceptance of all control wiring installed for mechanical systems by Electrical Contractor. Such approval shall be given within thirty (30) days of completion of all such control wiring. Two (2) copies of letter shall be sent to Engineer.

END OF SECTION

SECTION 26 05 03 – COMPLETION AND STARTUP

PART 1 **GENERAL**

1.01 **WORK INCLUDED**

- A. Furnish material and labor required to perform startup of equipment and systems installed in this project and provide operating and maintenance instructions to the Owner. Coordinate, schedule and perform this work with the Commissioning Engineer.
- B. Furnish labor and material required to inspect the installed systems and correct deficiencies as specified herein.
- C. Furnish labor and equipment required to maintain clean work areas throughout the project and to perform final cleanup.

1.02 **RELATED WORK**

- A. General Provisions: Section 26 05 01
- B. Assignment of Miscellaneous Work: Section 26 05 02

PART 2 **PRODUCTS**

2.01 NOT USED

PART 3 **EXECUTION**

3.01 **COMPLETION REQUIREMENTS**

- A. Remove rust, scale and foreign materials from equipment and renew any defaced surfaces. If equipment is badly marred, Engineer shall have authority to request that new materials be provided.
- B. Provide continuing adjustment services as necessary to insure proper functioning of all electrical systems after building occupancy and during warranty period.

3.02 **STARTUP**

- A. A pre-startup construction meeting shall be scheduled by the Mechanical Contractor for the specific purpose of achieving a coordinated systems startup with the Commissioning Engineer and Owner.
- B. The Commissioning Engineer, Owner, Mechanical Contractor, Sheetmetal Contractor, Temperature Control Contractor, Balancing Contractor and Electrical Contractor shall be present at the pre-startup meeting and at the initial startup of each mechanical system and air handling unit.
- C. Check for proper electrical services and usage during the startup procedure.

3.03 **TEMPORARY USE OF NEW EQUIPMENT**

- A. The warranty on the equipment will not begin until the date of Owner's final

acceptance at the completion of the project.

- B. Should the Owner elect to receive beneficial operation of the equipment prior to final acceptance, he may do so. The warranty period may begin then upon the Contractor receiving written approval from the Owner accepting the equipment with conditions of any incomplete portions of the work.

3.04 TOUCH-UP

- A. All electrical equipment, cabinets, panels and other enclosures shall be cleaned and paint touched up as necessary to duplicate factory finished appearance. Touch-up paint shall exactly match color, composition and quality of factory applied finish.
- B. Equipment furnished with factory applied finish shall be protected from injury by the installing contractor. Any damaged surface shall be repaired by the installing contractor to match original finish or shall be replaced before final acceptance.

3.05 CLEANING

- A. Maintain a clean project site throughout the construction period. Provide personnel to regularly remove debris and unused materials. Coordinate this cleaning effort with your subcontractors.
- B. Remove all debris and unused materials from job site created by electrical work.
- C. Clean all electrical equipment to a "like new" condition in preparation of final inspection. Vacuum clean all internal components.
- D. Clean all mechanical and electrical rooms and/or areas of debris and unused material.

3.06 RAISED FLOOR PLENUM CLEANING

- A. Maintain a clean raised floor plenum throughout the entire construction period. Provide personnel to perform daily cleaning of activities on the base floor of the plenum.
- B. Provide periodic vacuum cleaning of the plenum.
- C. Do not operate the air system unless the plenum has been cleaned.

3.07 TRAINING

- A. After final completion, provide instruction to Owner designated personnel.
- B. Provide a minimum of four (4) hours of training to the Owner. This training is to include, but not limited to, electrical equipment dedicated to the project such as:
 - a ATS
 - b Generator
 - c Circuit Breakers (LSI)
 - d Lighting Contactor
 - e Low Voltage/IT (if not under Division 27)

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- i Cameras
 - ii Access Control
 - iii Intercom
 - iv Overhead PA System
 - f Fire Alarm
 - g Elevator
 - h Crane
 - i Truck Hoist
 - j Automatic doors
 - k Disconnect Switches
 - l Any Specialty Equipment
- C. Training shall be coordinated with Owner's personnel to meet their needs.
- D. Training to occur in maximum of 2-hour increments per personnel or groups of personnel.
- E. Training plan, time line, and agenda shall be provided to Owner and signed off by Owner and Contractor.
- F. Warranty certificate and agreement shall be provided to Owner at initial training session.
- G. Provide a digital video copy of the training sessions.
- H. Contractor to be present at first two (2) uses of the facility.

END OF SECTION

SECTION 26 05 05 – CONCRETE PADS AND CURBS

PART 1: GENERAL

1.01 WORK INCLUDED

Furnish and install cast-in-place concrete pads and curbs for equipment where shown on the drawings and as specified herein.

1.02 RELATED WORK

- A. General Provisions: Section 26 05 01
- B. Assignment of Misc. Work: Section 26 05 02
- C. Switchboards: Section 26 24 13
- D. Low Voltage Distribution Transformer: Section 26 22 13

1.03 SUBMITTALS

Submit complete shop and setting drawings in accordance with Specifications Section 26 05 01, General Provisions.

PART 2: PRODUCTS

2.01 CONCRETE FORMWORK

- A. Design criteria: conform to tables for form design in APA Form V345, including strength.
- B. Lumber: construction standard grade.
- C. Plywood: exterior type softwood plywood, PS 1.
- D. Ties: carbon steel, snap ties, 1" breakback, 1/4" maximum diameter.
- E. Form coatings: non-staining
- F. Form Joint Tape: closed cell foam.

2.02 CONCRETE REINFORCEMENT

A. Materials

1. Bars: deformed billet steel: ASTM A615, Grade 40.
2. Wire:
 - a. Cold drawn steel: ASTM A82
 - b. Deformed steel: ASTM A496
3. Tie Wire: FS-QQ-W-461, annealed steel, black 16 gauge, min.
4. Welding Electrodes: AWS A5.1, low hydrogen, E70 Series.
5. Splice Devices: sized to develop 125% of yield strength of bar.
6. Bar supports: conform to "Bar Support Specifications", CRSI Manual of Standard Practice, Chapter 3.
7. Wire Fabric: welded steel, ASTM A195

B. Placement: Set reinforcing accurately and tie all items securely.

C. Pin all interior pads and curbs to floor slabs, with dowels or bars (exception: do not pin to post tensioned slabs).

2.03 EXPANSION AND CONTRACTION JOINTS

A. Joint Filler: Pre-molded, treated, non-bituminous, non-extruding wood fiber in concrete color and compatible with specified sealants. Filler shall conform to the performance requirements of ASTM D1752, Type 1.

B. Acceptable Manufacturers

1. Everlastic
2. Rescor
3. Homex 300
4. Sponge Rubber
5. Williams Products
6. W.R. Meadows
7. Homasote
8. Construction Gaskets

2.04 CAST-IN-PLACE CONCRETE

A. Interior: 4000 PSI, ready mix, to conform to ASTM C94.

B. Exterior and Below Grades: 4000 PSI with 4% - 6% air entrainment.

C. Slump: 5 inch maximum, tolerance, zero plus and minus 2 inches.

D. Concrete shall be thoroughly consolidated without honeycombed finish surface.

E. Provide 1" chamfered edges on perimeter of all pads.

2.05 CONCRETE FINISHING

- A. Interior Pads
 - 1. Provide smooth (floated) sides and top.
 - 2. Grind smooth all chamfered edges
- B. Exterior Pads
 - 1. Provide smooth (troweled) sides
 - 2. Provide broom finish top
 - 3. Grind smooth all chamfered edges

2.06 CONCRETE CURING

- A. Apply concrete curing compound only at exposed slab.
- B. Acceptable Manufacturers
 - 1. Curetox - Toch Brothers
 - 2. Sealtight AR-30C - W.R. Meadows
 - 3. Promulsion 100 - Protex

PART 3: EXECUTION

3.01 INSTALLATION

- A. Provide 3-1/2" (Nominal 4") concrete housekeeping pads under all floor mounted Electrical Equipment.
- B. Coordinate location and size of pads with other concerned contractors.
- C. Expansion joints will not be permitted to cross limits of a piece of equipment.
- D. Concrete pad shall extend 6" past all sides of equipment.
- E. For exterior pads, all preparation and grading is the responsibility of the Electrical Contractor. Pad preparation includes, grading, leveling, stone backfill, reseeding as necessary for a completely installed pad.

END OF SECTION

SECTION 26 05 19 – LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

Part 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Performance Testing: Section 26 08 01
- C. Raceways and Boxes: Section 26 05 33

Part 2 **PRODUCTS**

2.01 WIRE AND CABLE (UP TO 600 VOLTS)

- A. UL Standards: UL 44 and UL 83.
- B. Insulation: color coded thermoplastic type rated 600 volts, 75-degree C except where otherwise noted.
- C. Conductors: soft drawn copper.
- D. Conductors #10 and Smaller
 - 1. For final connections to motors, light fixtures and all locations where vibration or movement is present use Class B, stranded conductors.
 - 2. For all other locations use solid conductors. Stranded conductors may be used on #12 and #10 wire, provided terminations under screw terminals are made using insulated spade connectors such as "Sta-Con" or other approved equivalent connectors.
- E. Conductors #8 and larger: double braid, Class B concentric stranded per ASTM B8.
- F. Minimum Wire Size: General #12; Over 100' #10; Over 200' #8; Control #14; Signal #18 or as detailed in appropriate section of the specifications and/or as shown on the drawings. Contractor shall adjust wire sizes to insure that voltage drop in branch circuits does not exceed 3 percent to the farthest outlet and that the maximum total voltage drop in both feeder and branch circuits does not exceed 5 percent to the farthest outlet. Contractor shall adjust wire sizes to insure that voltage drop in branch circuits does not exceed 3 percent to the farthest outlet and that the maximum total voltage drop in both feeder and branch circuits does not exceed 5 percent to the farthest outlet.
- G. Aluminum Wire: contractor may use cable with compressed aluminum conductors in lieu of copper conductors for sizes #1 AWG and larger provided that:
 - 1. All lugs or terminals used are approved for use with aluminum conductors and are of the compression type and are increased in size as necessary to accommodate larger conductor size.
 - 2. All lugs or terminals are sized to accept increased size of conductors accounting for voltage drop.
 - 3. All terminations are treated with an anti-oxidizing compound similar to Burndy Penetrox or Penn Union CUAL Acid.

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4. Sizes of conductors and conduits are increased to provide equivalent ampereage and conduit fill indicated by copper conductors specified.
 5. Aluminum may only be used on AWG #1 and larger, provided no splices are used.
 6. Copper wiring is used for all branch circuit wiring from panelboards/load centers.
- H. Types and Uses (unless otherwise specified or indicated on the drawings). All conduit sizing is based on Type THWN and THHN. (Conduits may need to be increased in size if other wiring is selected).
1. Feeders and service entrance conductors: THWN or THW
 2. Power circuits above 40 amps: THWN or THW (#8 or larger)
 3. Branch lighting, receptacles and small power circuits: THWN (#10 and #12)
 4. Branch circuits in wiring channels of continuous rows of fluorescent lighting fixtures: THHN or THWN
 5. Direct burial feeders and branch circuits: UF
 6. Control Wiring: MTW (#18 and #16)
- I. Wire Tags: Main and feeder cables shall be tagged in all pull boxes, wireways and wiring gutters of panels. Tags shall identify wire or cable number and/or equipment served as shown on the drawings. Tags shall be of flame resisting adhesive material, T & B Type WSL or approved equal.

2.02

CABLE LUGS AND TAPS

- A. Large Cables (No. 8 and larger)
1. Use compression type connectors, taps and splices specifically designed for the particular connection; insulated splice "Bakelite" covers designed to fit around splice. Mechanical lugs approved for use with copper cables only.
 2. Manufacturers: Burndy Engineering Co., Inc. Thomas & Betts, or approved equal.
- B. Branch Circuit Wires (No. 10 and smaller): Use any of the following type of terminals and connecting devices.
1. Hand applied: coiled tapered, spring wound devices with a conducting corrosion-resistant coating over the spring steel and a plastic covered and skirt providing full insulation for splice and wire ends. Screw connector on by hand. Manufacturers: Ideal Industries "Wing Nut"; Thomas & Betts "Piggy"; 3M Company "Scotchlok"; or approved equal.
 2. Tool applied: steel cap with conducting and corrosion-resistant metallic plating, open at both ends, fitted around the twisted ends of the wire and compressed or crimped by means of a special die designed for the purpose. Specially fitted plastic or rubber insulating cover wrap over each connector. Manufacturer: Thomas & Betts "Staken"; Ideal Industries "No. 410 Crimp Connector" and "Wrap-Cap"; Buchanan; Burndy; or approved equal.

2.03

CABLE SUPPORTS IN RISERS

Clamping devices employing insulating wedges at code required locations or as indicated. O.Z. Type S or approved equal.

2.04 ELECTRICAL INSULATING TAPE

- A. Tape shall be specially designed for use as an insulating tape.
- B. Manufacturers: Scotch #23 (rubber), Scotch #33 (plastic) or equal by Johns-Manville; Minnesota Mining.

2.05 MANUFACTURERS

Southwire, Rome Carroll, American, Okonite, Encore, Pirelli, AFC Cable Systems or approved equal.

Part 3 **EXECUTION**

3.01 INSTALLATION

- A. Run all wire in approved conduit, unless otherwise specified, shown on the drawings or directed.
- B. Run all wires of same circuit in same conduit. Maximum number of current carrying conductors in conduit shall be six.
- C. No wire to be pulled until conduit installation is complete.
- D. Pull no thermoplastic insulated wire if temperature is lower than 33°F.
- E. Use approved pull-in compound (similar to Wire-Lube or Y-Er-Ease) to facilitate pulling of wire. Grease or oil not permitted.
- F. Splice and connect wires only in readily accessible boxes.
- G. Care shall be exercised when installing wire so as not to injure the conductor insulation. Lubricating compounds, recommended by the cable manufacturer, may be used when pulling wire or cable.
- H. Bending radius and maximum pull tension of any insulated wire or cable shall not exceed the limits recommended by the Manufacturer.
- I. Splices shall not be permitted except for lighting and as shown on the drawings. After splicing, insulation tape equal to that on the spliced wire shall be applied to each splice but not less than two (2) layers of rubber tape covered by two (2) layers of plastic tape.

3.02 WIRE AND CABLE IDENTIFICATION

- A. Color code wire #10, #12 and #14 AWG as follows:

	<u>208V/120V</u>	<u>480V/277V</u>
Phase A	Black	Brown
Phase A	Red	Orange
Phase A	Blue	Yellow
Neutral	White or Gray	Gray
Ground	Green	Green with Yellow Stripes

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- A. Identify control wires at terminations with numbers shown on the Control Drawings.
- B. Train and lace wiring inside equipment and panelboards with plastic tie wraps for a neat appearance.
- C. Make all spare wires in cabinets or panelboards of adequate length for connections. Terminate with insulating tape and tag.
- D. Factory color code all cables.
- E. Circuit/panel identification
 - 1. Provide identification of all panel and motor feeder cables and control wires in pull boxes and at terminations.
 - 2. Use flameproof cloth, vinyl plastic or aluminum foil markers for labels wrapped around wire.
 - 3. Mark tags on power cables with panel and circuit name in black on a yellow background.
 - 4. Mark tags on control wires with terminal numbers and circuit name in black on a yellow background.
 - 5. Use pre-printed markers with protective coatings wherever possible. Use only black India ink or permanent write-on markers.
 - 6. Manufacturer: Brady Slip on Markers

3.03 WIRE CONNECTIONS AND DEVICES

- A. Thoroughly clean wires before installing lugs and connectors, so that joint will carry full capacity of conductors without perceptible temperature rise.
- B. Use lugs or connectors of sufficient size to enclose all strands of conductors.

3.04 PULL CABLES

Insert nylon pulling cable with carbon dioxide, compressed air or vacuum.

3.05 277 VOLT LIGHTING AND 480 VOLT CIRCUITS

- A. Test cables with 1000 volt megger between phases and between each phase and ground, with test maintained until readings are steady for three minutes. Readings to be equivalent to the manufacturer's specifications and similar readings not to deviate more than 5%.
- B. Tests must be conducted in the presence of the Owner's representative.

END OF SECTION

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Lightning Protection for Buildings: Section 26 41 13.13

PART 2: PRODUCTS

2.01 GENERAL

- A. Entire installation to be grounded and bonded in accordance with requirements of Article 250 of the National Electrical Code (NEC).
- B. Equipment grounding shall be provided for, but not limited to, the following items:
 - 1. Panelboard tubs, switchboard frames, transformers and electrical structures.
 - 2. All motor frames that are not otherwise effectively insulated from ground.
 - 3. Enclosure for motor controllers and safety switches.
 - 4. Raised computer floor support pedestals.
 - 5. All metal objects with 10'-0" of a swimming pool.
- C. Provide code size grounding conductor in all conduits and raceways.
- D. An equipment bonding jumper shall be used to connect the grounding terminal of a grounding type receptacle to a grounded box.
- E. All grounding type receptacles are to have grounding slot connected to green ground conductor.

2.02 EQUIPMENT GROUND

- A. Existing telephone and electrical grounds shall be maintained at all times. Temporary ground shall be made during any transition period affecting grounding capability.
- B. Provide C.O. ground bus in tele/data equipment rooms with 3/0 MCM, "THW" grounded electrode conductor extended back to AC ground.

2.03 AC SYSTEM GROUND

- A. Ground system shall consists of 3 ground rods in triangle pattern or in a straight line 12'-0" apart. All ground rods shall be 3/4" diameter, 8'-0" sectional, Copperweld Blackburn, Penn Union or Weaver rods driven to a depth required to obtain ground resistance stated below.
- B. In addition to the triangle pattern ground rod system, ground to the street side of the water meter using OZ-Gedney Type 'BJ' Jumper, to foundation rebar, and to building steel as required by the NEC. After the ground system has been installed, but before it is fully covered, it shall be tested and shall be modified as required to obtain the ground resistance specified.

PART 3: EXECUTION

3.01 GENERAL

- A. All grounding system connections shall be made using a thermoweld process similar to "Cadweld" and Thermoweld or a high pressure (non-reversible) compression type system similar to Burdy "Hyground".
- B. Test resistance to ground of ground system or grounding network at point where equipment, raceways and conductors are to be connected. Value of this resistance to ground shall not exceed 5 ohms and shall be measured from ground being tested to the system ground rod driven into the earth.
- C. Ground system tests shall be performed by qualified testing concern normally employed in this field using nationally acceptable test instruments. All test reports shall be certified and shall be submitted to the Engineer for review.
- D. Bond conduits at panels per NEC.
- E. No equipment rated at more than 150 volts to ground shall be grounded in a manner which will permit the building steel to provide the only return path for ground fault currents.
- F. Grounding wire run below grade shall be buried 18" deep (minimum).
- G. All contact surfaces shall be thoroughly clean and bright, before connection are made, to insure making good electrical contact.
- H. Each feeder conduit shall have all joints made with conductive, waterproof joint compound as Sherwin Williams "Zink Clad", T & B "Kopr/Shield" or approved equal.

3.02 GROUNDING SYSTEMS TESTS

- A Visual and Mechanical Inspection: Inspect ground system for compliance with plans and specifications.

- B Electrical Tests
 - 1. Perform 3-point fall-of-potential test per IEEE Standard No. 81, Section 9.04 on the main grounding electrode of system.
 - 2. Perform the 2-point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points.
 - 3. Alternate Method to 2 above: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point. This test shall be made by passing a minimum of ten amperes DC current between ground reference system and the ground point to be tested. Voltage drop shall be measured and resistance calculated by voltage drop method.

- C Test Values: The main ground electrode system resistance to ground should be no greater than five ohms.

END OF SECTION

SECTION 26 05 33 – RACEWAYS AND BOXES

Part 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19

1.02 PENETRATIONS

Penetrations of fire rated walls, floors, roofs and ceiling will be sealed with rated fire stops by General Contractor.

1.03 WORK INCLUDED

- A. Furnished all labor, materials and equipment necessary to provide all sleeves and anchors as shown on the drawings.
- B. Any and all penetrations of below grade walls with conduit shall be protected by a sleeve with water sealing assemblies.

Part 2 **PRODUCTS**

2.01 METALLIC TYPE CONDUITS

- A. Rigid Galvanized Steel (RGS): UL 6 and ASA C80.1 Full weight mild galvanized or sheradized steel pipe of standard pipe dimensions; with screwed fittings. Bushing shall be malleable iron. Bushings 1-1/4" and larger shall be insulated throat and grounding lug.
- B. Rigid-Aluminum-Heavy Wall Type (RA): Heavy Wall aluminum pipe of standard pipe dimension.
- C. Intermediate Metal Conduit (IMC): UL 242, Lighter weight galvanized or sheradized steel pipe of standard pipe dimension with full weight screwed fittings. Bushings shall be malleable iron. Bushings 1-1/4" and larger shall have insulated throat grounding lug.
- D. Electrical Metallic Tubing (EMT): UL 797 and ASA C80.3, Galvanized or sheradized thinwall steel conduit. Fittings 1-1/4" and larger shall have nylon insulated throat. Indentor or drive-on fittings are not acceptable.
- E. Flexible Metal Conduit (FMC): UL 1, Galvanized, single strip type with smooth wiring channel. Use in dry locations and for connections to motors, transformers, lighting fixtures and other equipment that may have movement or vibration. Fittings shall be steel.
- F. Liquid tight flexible metal conduit (LFMC): UL 360 galvanized, single strip with smooth wiring channel and neoprene jacket. Fittings shall be compression type. Use in moist locations for final connections to motors, transformers, lighting fixtures or other items with movement or vibration.

2.02 POLYVINYL CHLORIDE TYPE (PVC)

- A. PVC pipe of standard pipe dimensions suitable for use with socket type solvent weld couplings, boxes and fittings.
- B. Conduit shall be PVC Schedule 40 or 80 (90°C) for application in underground, encased and exposed applications in accordance with NEC. Where exposed, Schedule 80 shall be used to 8 feet above floor or grade.
- C. PVC conduit and fittings shall be UL rated for electrical use. Material shall comply to NEMA Specifications TC-2, TC-3, Federal Specifications W-C-1094A, UL-651 and ANSI C33.91.
- D. Conduit shall be made from virgin polyvinyl chloride C300 to reduce smoke and HCL emissions in a fire situation. Conduit shall be rated for UV (ultraviolet) resistance for above ground installations outdoors or where exposed to ultraviolet radiation.
- E. Conduit, fittings and solvent weld cement shall be produced by same manufacturer to assure system integrity.
- F. Use metallic conduit for all 90-degree ells from below grade into building to protect conduit from damage.
- G. Manufacturers: Carlon PV-Duct Plus Systems or approved equal.

2.03 FIRE STOP SEALANTS

- A. Penetration Sealants
 - 1. Dow Corning "Firestop Foam" and "Firestop Sealant"
 - 2. Insta-Foam Products, Inc. "Insta-Foam Seal Silicone RTV Foam"
 - 3. 3M Brand "Fire Barrier" Caulk
 - 4. 3M Brand Moldable Putty "Pads" and Moldable Putty "Stix"
- B. Intumescent sealants for use in openings and sleeves involving plastic pipe, insulated pipe or flexible cable:
 - 1. Dow Corning "Firestop Intumescent Wrap Strip"
 - 2. Fox Coupling, Inc. "Cast-In-Place Firestop Coupling"
 - 3. 3M Brand "Fire Barrier" Caulk with FS-195 wrap strip and CS-195 composite sheet.
- C. Firestop Pillows
 - 1. Metacaulk® PILLOWS
 - 2. BIOSTOP™ Firestop PILLOWS
 - 3. 3M Firestop Pillows
- D. Wall Opening Protective Materials
 - 1. LECTRA-STOP™ Fire Rated Electrical Box Inserts, by BIO FIRESHIELD™
 - 2. BIOSTOP™ Fire Rated Putty Pads
 - 3. 3M Moldable Putty Pads
 - 4. Metacaulk® BOX GUARD™ Fire Rated Electrical Box Inserts, By

- RectorSeal Corporation
- 5. Metacaulk® Putty Pads
- 6. Metacaulk® Cover Guard™
- 7. Bio Fireshield™ Firestopping Gasket

E. Accessories: as specified by the tested assembly and:

- 1. Forming/Damming Materials: Mineral fiberboard or other type recommended by manufacturer's tested system.
- 2. Primer, Sealant and Solvent Cleaner: As recommended by manufacturer's tested system.
- 3. Fasteners, universal restricting collars, etc. as recommended by the manufacturer's tested system.

2.04

METALLIC STEEL OUTLET BOXES

- A. General use interior boxes shall be galvanized die cast pressed steel units of proper depth and gauge required by the outlet location. Boxes shall be equipped with plaster ring or cover as necessary. These units shall be manufactured by Raco, Steel City or approved equal.
 - 1. Wall outlets: 4" square x 1-1/2" deep (minimum) with plaster ring as required.
 - 2. Ceiling outlet: 4" square or octagonal x 1-1/2" or 2-1/8" deep with stud or ears where required.
 - 3. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide outlet boxes of the type and size suitable for the specific application.
- B. Exposed outlets: malleable iron or heavy cast aluminum with threaded hubs, Type FS, FD or GS as manufactured by Crouse Hinds, Appleton, Killark or approved equal. Die cast stamped steel boxes are not acceptable.
- C. Special system and equipment outlet boxes shall be as recommended by the manufacturers of this equipment. Construct junction or pull boxes not over 150 cubic inches in size as standard outlet boxes and those over 150 cubic inches the same as "cabinets" with screw covers of the same gauge metal.
- D. Telephone/data rough-ins shall consist of a 4" square x 1-1/4" deep (minimum) with plaster ring as required with 3/4" conduit stubbed up to above ceiling and bushed. (One rough-in = 3/4" conduit, two rough-ins = 1" conduit, three rough-ins = 1-1/4" conduit.)
- E. Back-to-back outlets in the same wall or "thru-wall" type boxes are not permitted. Provide 12" (minimum) long nipple to offset for all outlets shown on opposite sides of a common wall to minimize sound transmission. Provide 24" (minimum) offset for boxes in fire rated walls to comply with code.
- F. Unless otherwise noted, locate outlets as follows. Heights listed are from finished floor to center of device. Mounting heights for other equipment are as shown on the electrical or architectural plans or as herein further indicated.

1. Convenience and signal outlets: 18 inches above finished floor unless otherwise noted.
2. Lighting switches: 4 feet, 0 inches
3. Outlets: 18 inches above finished floor
4. Where counter occur, mount all devices 44" AFF to top

2.05

POLYVINYLCHLORIDE NON-METALLIC OUTLET BOXES

- A. Junction boxes in exposed overhead conduit runs shall be round type with 4-1/2" and 3/4" knockout socket openings. Similar to Carlon E970D and E970E.
- B. Outlet and switch boxes in walls shall be single gang type with one or two 1/2" or 3/4" knockout sockets openings. Similar to Carlon FSS of FSC series.
- C. Outlet boxes in ceiling slabs shall be 2-1/2" deep 4" octagonal stamped steel concrete type box. Each box to be liberally coated inside and outside with spray on PVC coating similar to Carlon.
- D. All junction and outlet boxes shall be of a NEMA Type 3R construction in wet outdoor areas and NEMA Type 12 in moist indoor areas.
- E. Junction boxes with screw down covers shall be fully gasketed and shall be available in the following sizes:
 1. 4" x 4" x 4" Similar to Carlon E987N
 2. 6" x 6" x 6" Similar to Carlon E987R
 3. 8" x 8" x 8" Similar to Carlon E989N
 4. 12" x 12" x 12" Similar to Carlon E989R

2.06

ANCHORS AND FASTENERS

- A. Anchors and fasteners shall be of a type designed and intended for use in the base material to which the material support is to be attached and shall be capable of supporting the intended load and withstanding any associated stresses and vibrations.
- B. In general, screws shall be used in wood, masonry anchors on concrete or brick, toggle bolts in hollow walls, and machine screws, bolts or welded studs on steel.
- C. Nails shall not be used except for temporary support or for light loads in wood frame construction.
- D. In outdoor locations or other corrosive atmospheres, the anchors and fasteners shall be non-corrosive or have suitable corrosion resisting coatings.

2.07

JUNCTION AND PULL BOXES

- A. Special junction boxes shall be sized as required for the conductors and number of splices they are to house. They shall be made from galvanized sheet metal and sized in accordance with the National Electric Code (NEC).
- B. Type: code gauge sheet steel, galvanized sized in accordance with NEC.
- C. Covers: screw attached except as noted.

2.08

WALL SLEEVES

- A. Each sleeve shall consist of a sleeve body, oversized conduit and a pressure clamp, pressure ring and sealing grommet.
- B. The basic design of the sleeve shall be such that will allow the sleeve body and sleeve conduit to be cast into the concrete walls and the sleeve pressure clamp to be installed at a later date.
- C. The sleeve body and conduit shall be so designed to accept several different size pressure clamp assemblies.
- D. Sleeve Construction shall be as follows:
 - 1. Body: the body shall be malleable with hot dip galvanized finish. Provide ground lug connection for #8 AWG copper conductor. Sleeve body shall have a sealing ring between the body and the conduit sleeve.
 - 2. Conduit Sleeve: the conduit sleeve portion shall be oversize PVC sleeve.
 - 3. Pressure Clamp and Pressure Ring with Sealing Grommet: the body shall be so designed to accept the following:
 - a. Pressure Clamp: shall be constructed of malleable iron with hot-dip galvanized finish with hex headscrews that anchor into the sleeve body.
 - b. The sealing grommet shall consist of an expandable type long lasting elastic material that is sandwiched between two (2) malleable hotdip galvanized pressure plates. All sized for the exact O.D. thickness of conduit that will pass through the sleeve.
- B. Manufacturer: similar to O-Z/Gedney type "FSK" #1020, 2030, 3040 or 4050 as indicated on drawings.

Part 3

EXECUTION

3.01

CONDUIT USAGE

(All conduit types noted are acceptable for use listed.)

A. General

	<u>Conduit Types</u>			
1.	Underground electrical & telephone service entrance	RGS	IMC	PVC
2.	Electrical & telephone services other than underground	RGS		
3.	Conduits in concrete slab	RGS	IMC	PVC
4.	Conduits below lowest floor slab	RGS	IMC	PVC
5.	Hazardous Area Class I, Div. I or II, Class II, Div. I or II (aluminum not acceptable in moist alkaline environments)	RGS	IMC	RA
6.	Conduits in moist locations or exposed to weather	RGS	IMC	RA
7.	Feeders, power circuits (1-1/4" and larger)	RGS	IMC	RA
8.	Branch lighting and receptacle circuits (up to and including 60 amp)		IMC	EMT
9.	Underground to remote locations. (Rigid or IMC	RGS	IMC	PVC

	must be liberally coated with asphaltum)			
10.	Final connections to motors, transformers or other equipment requiring vibration isolation. (max length of 36")	FMC	LFMC	MC
11.	From junction box to recessed lighting fixture	FMC	LFMC	MC
12.	Short connections where use of rigid is impractical (must be approved by Engineer prior to installation)	FMC	LFMC	MC
13.	For mechanical protection	RGS	RA	IMC
14.	Final connections to motors, transformers, under computer floors or other equipment in moist locations requiring vibration isolation. Maximum length of 36" unless otherwise noted.		LFMC	
15.	All other locations unless otherwise noted			EMT
16.	For ground electrode connectors	PVC		
17.	Fire alarm	RGS	IMC	EMT
18.	Security (access control and CC Cameras)	RGS	IMC	EMT

NOTE:

RGS:	Rigid galvanized steel
IMC:	Intermediate metal
EMT:	Electrical metallic tubing
PVC:	Polyvinyl chloride
FMC:	Flexible metal conduit
LFMC:	Liquidtight flexible metal conduit
RA:	Rigid aluminum
MC:	"MC" cable

- B. Conduit fill shall be limited to not more than six (6) conductors, not including ground conductor.

3.02 PULL WIRES

- A. RGS, IMC, EMT: Use steel, nylon or polypropylene pull wires.
- B. PVC, RA, FMC, LFMC: Use nylon or polypropylene only.

3.03 CONDUIT INSTALLATION (GENERAL)

- A. Conduit system to be electrically continuous and shall be grounded in accordance with NEC. Separate grounding conductors to be used in all conduits.
- B. All conduit terminations to be equipped with locknuts and bushings. Conduits 1-1/4" and larger shall have insulating bushings, grounding lug and shall have locknuts inside and outside the enclosure.
- C. Conduits to be supported by pipe straps or trapeze hangers shall have their supports spaced not more than 8'-0" on center. Secure supports by means of toggle bolts, inserts or expansion bolts. MC cable shall be supported at distances no greater than 6 feet and with 12 inches of terminations at boxes and panels. PVC conduit shall be supported at distances not greater than the distances as required by NEC table 352.30.
- D. Conduits to be supported by wall brackets shall have their supports spaced not more than 4'-6" on center. Secure supports by means of toggle bolts, inserts or expansion bolts.

- E. Conduits shall be supported directly from structural members not from ceiling suspensions system, ductwork, air handling units, pump bases, piping, etc. Additional supports shall be provided at junction and pull boxes.
- F. Conceal raceways in floors, walls, ceilings or furred spaces in finished areas unless otherwise noted on drawings.
- G. Support single horizontal conduits 1-1/4" and larger by means of rod and cast ring hangers. Support multiple horizontal runs of conduit in similar manner or use common trapeze hanger similar to Unistrut P2000 or P4000 as required for span and loading. Provide end caps on Unistrut type hangers in mechanical rooms. Conduits on Unistrut may be fastened by means of heavy galvanized steel straps if the Unistrut is above 7'-0" above finished floor.
- H. Surface mounted horizontal and vertical conduit supports on walls up to a height of 7'-0" above the floor shall be one or two hole sheet metal pipe straps. Pinch type hangers similar to Minerallac type may only be used at heights greater than 8'-0". The use of pinch type hangers similar to Minerallac type are expressly prohibited on ductwork, air handling units, and other mechanical equipment below 8'-0".
- I. Protect conduits during construction with temporary plugs or caps. All conduit shall be securely capped until wire or cable is installed therein.
- J. Minimum conduit size is 1/2". Except for homeruns to panels which shall be 3/4".
- K. No conduit shall be installed in elevated or supported concrete slabs except as noted on Structural Drawings and/or as approved by Structural Engineer.
- L. Provide three 1" conduits stubbed out into furred ceiling space above each flush mounted panelboard or cabinet.
- M. Running conduit horizontally in walls is not permitted. Convenience outlets, switches or other devices located on or in walls shall be individually fed overhead from ceiling unless otherwise noted or indicated on the drawings.
- N. Furnish expansion fittings where raceway crosses the building expansion joints. (O.Z. Type AX, EX, EXDS, TX, EXE or approved equal.)
- O. Provide pull wire in all conduits where other contractors or utilities are to install cables (i.e.: telephone, computer and other such conduit systems).
- P. Electrical drawings show the intended arrangement and electrical equipment and devices, they shall be followed as closely as actual building construction will allow. The Contractor shall coordinate his work with the different trades so that interferences between conduit, cable tray, piping, equipment, architectural and structural work shall be avoided. Should an interference arise, the Contractor shall inform the Engineer before proceeding with the work. Should the Contractor fail to contact the Engineer and interferences develop, the Owner's Representative will decide which equipment, piping, etc. must be replaced, regardless of which was installed first. The relocating shall be performed at no expense to the Owner.
- Q. Conduit shall be continuous between power source, equipment, junction or pull boxes and fittings, and shall enter and be secured to all boxes in such a manner

that each system shall be electrically continuous from point of service to all outlets.

- R. There shall not be more than the equivalent of three 90° bends in any single run of conduit between outlet boxes or fittings. Bends shall be made so that the conduit will not be flattened or kinked and that the internal diameter of the conduit will not be reduced. The radius of the curve of the inner edge of any bend shall not be less than as indicated by the National Electrical Code.
- S. In no case shall any conduit be bent or any fabricated elbow be applied to less than the allowable bending radius, as specified by the cable manufacturer of the installed conductor.
- T. When it is necessary to make field bends, they shall be made with tools designed for conduit bending. Heating of metallic conduit to facilitate bending is not permitted.
- U. Conduit shall be installed so as to incorporate a minimum of one pull box or conduit fitting per 100 foot run for easy installation of wire.
- V. The Contractor shall not cut, burn or drill any structural member to mount electrical equipment or to facilitate tray or conduit installations without having previously received approval, in writing, from the Owner or Engineer.
- W. Use compression type fittings on all EMT conduit.
- X. Pulling of wire or cable shall be immediately preceded by a thorough cleaning of the conduit to make it completely free of water or foreign matter.
- Y. Mount all conduits a minimum of seven inches above any accessible type ceiling or with spacing as required to permit relocation of recessed fixtures to any location.
- Z. Below or in floor conduit installation is to be anchored to prohibit floating within the concrete floor installation. Obtain approval from a flooring consultant on the proper cutting and patching required for existing floor electrical installations to insure proper floor finish results.
- AA. Feeder conduits run under on grade tenant floor slab areas are to be installed a minimum of 36" below finished slab elevation, be concrete encased with a minimum of 3" cover and have a yellow warning tape installed 6" above the concrete encasement. Dimensioned as-built drawings showing final locations are to be provided to the Engineer and Owner immediately after the installation is complete. Conduit to be concrete encased may be Schedule 40 PVC.
- BB. Exterior site lighting conduit will be Schedule 40 PVC with a minimum size of 1". Burial depth shall be a minimum of 24" below grade or below the frost line, whichever is greater.
- CC. All conduit installed outdoors or in concrete shall be temporarily capped or plugged immediately after installation. Seal all conduit penetrations where conduit passes from wet to dry areas.
- DD. Conduits crossing building expansion joints shall include expansion joints for the conduits.

- EE. PVC conduit shall not be used from 18" below grade or finished floor to 10'-0" above grade or finished floor.

3.04

SURFACE RACEWAY

- A. Surface raceway shall be of metallic or non-metallic construction. Surface raceway shall be painted to match walls after installation. Vertical drops shall be installed in room corners. Low horizontal runs shall be installed directly above wall baseboard unless otherwise noted on drawings. A separate equipment grounding conductor shall be installed within surface raceways. Manufacturer's standard fittings and accessories made for use with the associated raceway shall be used.
- B. Single channel surface raceways for branch circuits and control wiring shall be like Wiremold 700 series as the minimum size metallic raceway and Panduit LD10 as the minimum size non-metallic raceway.

3.05

CONDUIT INSTALLATION (EXISTING AREAS)

- A. Conduit in existing structure may be reused under this contract if in good condition and meeting all requirements of the NEC and this specification.
- B. Raceways may be exposed in existing areas where concealment is impractical. Exposed raceways shall be run parallel to walls, floors and ceilings and shall be located to be as inconspicuous as possible. Surface raceways and boxes shall be used in finished spaces in instances where exposed raceways are permitted and used, unless otherwise noted on plans. Surface raceways may be Wiremold, Panduit, or equivalent.

3.06

SPECIAL CONDUIT LOCATION REQUIREMENTS

- A. Conduit run shall be kept at least six inches from insulated pipes, steam lines or any other hot pipes which they pass. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature, of the installation area.
- B. The location and sizing of conduit sleeves passing through floors, walls, etc. that are not shown on the drawings, shall be the responsibility of the Contractor subject to the Owner and Engineer's approval.
- C. Install all raceways concealed except at surface cabinets, for motor and equipment connection and in mechanical rooms.
- D. Provide flashing and counterflashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. which penetrate the roof.
- E. Route all raceways parallel or perpendicular to the building lines with right angle turns and symmetrical bends.
- F. Provide sleeves in forms for concrete walls, floor slabs and partitions for passage of raceways. Seal in an approved manner all raceway openings and sleeves through fire rated walls, floors and ceilings after raceway installation. Waterproof all sleeves raceways where required. Submit shop drawings showing locations of all sleeves through slabs, walls and masonry partitions.

3.07 CONDUIT INSTALLATION (RIGID AND IMC)

- A. Rigid and IMC conduit shall utilize threaded type fittings. Ends of conduit shall be threaded with five full threads and shall be reamed out to remove any rough edges and burrs. All conduit shall be thoroughly cleaned internally prior to installation of the conductors. Long threads known as "running threads" shall not be used. Field cuts on conduit shall be made with a hand or power saw or approved cutting machine and shall be made square.
- B. Conduit threads shall be coated with an approved conductive lubricant before the couplings are applied. Teflon tape shall not be used to lubricate any threaded conduit connections.

3.08 CONDUIT INSTALLATION (ALUMINUM)

- A. Use nylon pull ropes only with aluminum conduit.
- B. Lubricate screw threads with approved aluminum lubricant before assembling conduit fittings to pipe.
- C. Aluminum conduit shall not be used below grade, in contact with earth, or in contact with concrete.

3.09 CONDUIT SLEEVES

- A. Furnish, locate and set sleeves where conduit passes through floors, walls and other concrete or masonry structural materials except where tunnels, chases or shafts are provided in the construction. Sleeves through poured-in-place concrete floors shall be set prior to the pour and shall be of a design that will seal against passage of water between sleeves and concrete floor.
- B. Wall sleeves shall finish flush with walls. Floor sleeves shall extend 3" above finished floors unless otherwise specified.
- C. The void between the sleeve wall and conduit shall be neatly filled with an approved fire stop material.

3.10 CONDUIT INSTALLATION (HAZARDOUS AREAS)

- A. Conduit installation shall comply in all respects with the requirements of NEC for CLASS I or II, Division I or II, Group C or D installations. Conduit shall be threaded rigid type except where flexible connections are necessary such as connections to motors. Flexible connections shall be explosion-proof.
- B. All boxes, fittings and joints shall be threaded for connection to conduit.
- C. Threaded joints shall be made up of at least 5 threads fully engaged as described in NEC.
- D. Seals shall be provided as required by NEC in each conduit entering an arching device within 18" of the device, in conduits 2" or larger entering an enclosure and in conduit runs leaving a hazardous area. Seals shall be filled with proper compound approved for the purpose and as recommended by the manufacturer.

- E. Run conduit exposed and securely anchored to walls with strap type supports. Pinch type supports similar to Minerallac type shall not be used. Strap supports shall be Appleton 17151; Thomas & Betts 1277; or Midwestern Electric Co. 511.
- F. Run conduits vertically wherever possible to avoid use of horizontal seals. Where conduit is to be run horizontally, provide junction boxes in horizontal run with sealed risers to devices, rather than connecting directly between devices. See detail on the drawing.

3.11 FIRE ALARM CONDUIT

- A. Interior concealed dry spaces
 - 1. RGS, IMC, or EMT
 - 2. Where otherwise directed on drawings, or with Engineers approval, plenum rated, MC type cable specifically manufactured for use with Fire Alarm Systems shall be used in interior concealed dry spaces (MC-FPLP). Jacket shall have red coloring.
- B. Interior exposed, or in moist locations RGS or IMC shall be used.

3.12 UNDERGROUND RACEWAYS

- A. Low Voltage Feeder/Service Entrance
 - 1. The system shall consist of Schedule 40 PVC, IMC or RGS conduits. Concrete encased and quantity as indicated on drawings. Minimum conduit size is 4" unless otherwise noted on the drawings. Spacing between conduits shall be a minimum of 2" and the concrete envelope where required shall be 3" thick. Use end bell fittings where conduits terminate in manholes or building walls. Plastic conduit spacers shall be used to support conduits and to maintain proper spacing. Install polyethylene plugs on unused conduits. The top of ductbanks shall be minimum of 2'-6" below grade and shall be sloped to drain away from buildings. Install a magnetic type marking tape 1' above top of ductbank. Bends in ductbank shall be 30" minimum radius. Where concrete encased ductbank connects to a building install #4 re-bars in corner and tie to building wall reinforcing steel. Use similar method at manholes. At completion of construction of ductbank pull a brush or pig through all conduits in presence of Owner's representative to verify accessibility of conduit system.
- B. Low Voltage Branch Circuits
 - 1. Minimum burial depth of 2'-6" for Schedule 40 PVC is required. Junction boxes and covers for branch circuits shall be constructed of cast iron or cast aluminum with neoprene gaskets and stainless steel screws.
- C. Telecommunication System
 - 1. The underground raceway system for the telecommunication system shall be constructed with similar methods to those outlined above in paragraph 'A' except use Schedule 40 PVC conduit only for telecommunications ducts.
 - 2. Install "inner-duct" in one of the ducts as follows:

- a. Manhole-to-building" (1) 3 channel inner-duct, 1-1/2" channel.
- b. Inner-duct shall be U.L. listed for use with telecommunications/fiberoptic cabling systems.
- c. Manufacturers: Carlon or approved equal.

3.13 OUTLET BOX INSTALLATION

- A. Set box square and true with finished building surfaces and trim.
- B. Secure boxes firmly to building structure.
- C. Verify location of outlets and switches in finished rooms with Architectural Drawings of interior details and finish. In centering outlets and locating boxes, allow for overhead pipes, ducts and mechanical equipment, variations in fireproofing and plastering, window and like, and correct any inaccuracy from failure to do so without expense to the Owner.
- D. Maintain symmetry of all outlets as closely as possible within Architectural Section contained. For example, the Contractor shall center light fixture over doorway or receptacle in section of masonry wall, if shown in that approximate position. If receptacle is shown in same location as counter or bench, determine countertop height and set receptacle to clear top and trim of counter and render outlet easily accessible.
- E. In the event of conflict between locations of electrical outlets as shown on the Electrical Drawings and on the Architectural Drawings, outlets shall be installed in accordance with the latter.
- F. Locate light switches on latch side of door and verify door hinge location in field prior to switch outlet installation.
- G. Protect devices on outlets in locations where outlets are subject to injury, by means of wire guards or other approved means of protection. (Example: Provide wire guards on all "exit" signs, emergency egress lighting and other surface mounted equipment in gymnasiums).
- H. The Owner reserves the right to relocate any device as much as 10'-0" (measured horizontally) from it's indicated location at no additional cost, provided the contractor is notified prior to roughing that device in.

3.14 JUNCTION AND PULL BOX INSTALLATION

- A. Provide pull boxes wherever necessary to facilitate pulling of wire and as indicated.
- B. Locate junction and pull boxes as approved, generally not exposed in finished space unless otherwise indicated or approved by Engineer. Where necessary, reroute conduit or make other arrangements for concealment as required.
- C. Covers shall be accessible.
- D. Junction boxes for fixtures, recessed in hung ceiling, to be accessible through opening created by removal of the fixtures.

3.15 SLEEVE INSTALLATION

- A. Sleeves shall be mounted in concrete forms prior to concrete pour as recommended by sleeve manufacturer.
- B. Oversized PVC conduit sleeve shall be cut off to proper length prior to pour.
- C. Sleeve shall be capped at both ends as recommended by manufacturer to prevent entry of foreign material during concrete pour.

3.16 EPC-40-PVC CONDUIT INSTALLATION

- A. Conduit system to be continuous in accordance with NEC. Separate grounding conductors to be used in all conduit runs.
- B. All conduit terminations to be equipped with bushing type box adapters.
- C. Conduit to be supported by wall brackets or pipe straps on trapeze hangers spaced not more than 3'-0" on center. Secure supports by means of toggle bolts, inserts or expansion bolts. Pipe straps shall be so designed to allow expansion and contraction of pipe.
- D. Conduit above ceilings to be supported from structural system, not from ceiling suspension system. Additional supports shall also be provided at junction or pull box locations.
- E. Conceal raceways in floors, walls, ceilings or furred spaces in finished areas wherever possible.
- F. Protect conduits during construction with temporary plugs or caps.
- G. Short conduit runs of between 50 to 100' shall have expansion couplings with expansion capabilities of 2". Conduit runs over 100' shall have expansion couplings capable of expanding up 6". Expansion couplings shall be spaced on 150' center maximum for runs in excess of 300'.
- H. Minimum conduit size - 1/2".
- I. No conduit larger than 1" size to be installed in concrete slab.
- J. Provide code size green grounding conductor in all raceways. See NEC Table 250-95.
- K. Provide three 1" conduits stubbed out into furred ceiling space above each flush mounted panelboard or cabinet.
- L. PVC conduit turning up from below grade shall transition to RGS/IMC elbows at 18" below grade.

3.17 FIRE STOP INSTALLATION

A. General

1. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designated as insulation, safing, or otherwise. Firestopping shall preserve integrity of fire rating of barrier.
2. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.

B. Interior Walls and Partitions

1. Where a wall or partition is continuous past a structural floor, such as a stairwells and vertical shafts, and a space would otherwise remain open between the wall face and perimeter edges of the adjoining structural floor, provide firestopping.
2. Provide firestopping whether or not there are any clips, angles, plates or other members bridging or interconnecting the wall and floor systems, and whether or not such items are continuous.
3. Where the top edge of a fire-rated wall or partition abuts and is at right angles to fluted-type metal decking, and the construction is such that would otherwise leave the flute spaces open, provide firestopping.

C. Penetrations

1. Penetrations include conduit, cable, wire, pipe, duct or other elements which pass through one or both outer surfaces of a fire rated floor, wall, or partition.
2. Except for floors on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof, provide firestopping to fill such spaces in accordance with ASTM E-1966 and UL2079 for dynamic movement.
3. Where penetrations occur at fire-rated walls or partitions of solid-type construction, provide fire-stopping to completely fill spaces around the penetration, in accordance with ASTM E-814.
4. Where penetrations occur at fire-rated walls or partitions of hollow-type construction, provide fire-stopping to completely fill spaces around the penetration, on each side of the wall or partition, in accordance with ASTM E-814.
5. These requirements for penetrations shall apply whether or not sleeves have been provided and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, fire stop annular spaces - if any - between sleeve and wall of opening.
6. Where openings occur for expansion, at intersections of dissimilar rated construction, or control joints provide a rated joint system in accordance with ASTM E-1966 or UL 2079.

- D. Provide firestopping to fill miscellaneous voids and openings in fire-rated construction in a manner essentially the same as specified herein before.

E. General

1. Install of FireStops shall be performed by either a specialty contractor specializing in Firestop application (FM4991 Approved Contractor), or general or sub-contractors with experience in similar applications and projects with installers qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
2. Apply Firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
3. Coordinate with plumbing, mechanical, electrical and other trades to assure that all pipe, conduit, cable, and other items which penetrate fire rated construction have been permanently installed prior to installation of Firestops, schedule and sequence the work to assure that partitions and other construction, which would conceal penetrations, is not erected prior to the installation of Firestops.

- F. Dam Construction: Install dams when required to properly contain Firestopping materials within openings and as required to achieve required fire resistance rating. Combustible damming material must be removed after appropriate curing. Incombustible damming materials may be left as a permanent component of the Firestop system.

G. Fire Quality Control

1. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
2. Follow safety procedures recommended in the Material Safety Data Sheets.
3. Finish surfaces of firestopping which is to remain exposed in the completed Work to a uniform and level condition.
4. All areas of Work must be accessible until inspection by the application Code authorities.
5. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.

END OF SECTION

SECTION 26 05 40 – TRENCHING, BACKFILLING, AND COMPACTING

Part 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Electricity Metering: Section 26 27 13

1.02 REFERENCES

The latest issues of the following documents form a part of this specification to the extent hereinafter specified.

- A. American Society of Testing Materials (ASTM)
 - 1. D698 Standard Proctor Maximum Dry Density
 - 2. D1556-64 Density of Soil in Place by the Sand Cone Method
 - 3. D2167-66 Density of Soil in Place by the Rubber Balloon Method
- B. Indiana State Highway Commission Standard Specifications (ISHSS), Section 903, Aggregates

1.03 DELIVERY, STORAGE AND HANDLING

- A. Imported materials shall be stockpiled on site where directed if not ready for installation. Maintain segregation of differing materials.
- B. Do not deliver materials until ready for incorporation into the permanent work. Storage space is not available.

1.04 PROJECT/SITE CONDITIONS

- A. Subgrade and embankment protection
 - 1. During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained in such manner as to drain effectively at all times.
 - 2. Operate pumping equipment as required to keep the excavation free of water and subgrades dry, firm and undisturbed until approval of the permanent work has been received from the Architect.
 - 3. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped if required and recompact prior to the placing of surfacing.
 - 4. The storage or stockpiling of materials on a finished subgrade will not be permitted.
 - 5. Erosion control shall be performed by this Contractor until the installation of permanent vegetation, structures and erosion control devices.
- B. Protection of top soil areas: after placement of top soil, all such areas shall be protected from heavy machinery. All topsoil compacted by heavy machinery shall be removed and replaced at no additional cost to the Owner.

- C. Shore and brace excavations as necessary to prevent cave-ins.

Part 2 **PRODUCTS**

2.01 **MATERIALS**

Select Aggregate: No. 14-2 sand in accordance with ISHSS 903.01(g).

Part 3 **EXECUTION**

3.01. **INSPECTION**

Before commencement of work, verify the following with the documents associated with all site work.

- A. Verify installation of fences.
- B. Protective fencing for trees and plants has been installed as specified.
- C. Demolition of miscellaneous structures.
- D. Clearing and grubbing.
- E. Stripping and disposal of sod and stripping and stockpiling of topsoil.

3.02. **PREPARATION**

- A. Layout the various lines on the ground using stakes, flags or painting.
- B. Do not proceed with excavation until layout is approved.
- C. Set line and grade stakes as required or specified in the various sections covering the installation of conduits.

3.03. **TRENCHING**

- A. General: All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations and any water accumulating therein shall be removed by pumping or by other approved methods. Sheet piling and shoring shall be placed as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the conduit can be safely and properly installed and backfill can be compacted in such tunnel sections.
- B. Trench Excavation: Trenches shall be of the necessary width for proper laying of conduit. The banks of trenches shall be as neatly vertical as practicable. Care shall be taken not to over-excavate. The bottom of the trenches shall be accurately graded to provide a uniform surface for the type of bedding specified.

Stones shall be removed as necessary to avoid point bearing. Except as hereinafter specified for wet or otherwise unstable material, overdepths shall be backfilled as and with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the conduit is encountered in the bottom of the trench, such material shall be overexcavated to a depth to allow for construction of a stable conduit bedding.

C. Special requirements for specific utilities.

1. Electrical Conduits: unless otherwise indicated, trenches shall be excavated to a depth that will provide not less than 3 feet of cover over the top of the conduit from finished grade.
2. Excavation for Appurtenances: Excavation for manholes, junction boxes and similar structures shall be sufficient to leave at least 12" clear space between the outer surface of structure and the bank or timber that may be used to hold and protect the banks. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with sand, gravel or concrete as directed at no additional cost to the Owner.

3.04. BACKFILLING

- A. General: After bedding, the trenches shall not be backfilled until all required tests are performed. Except as otherwise specified for special conditions of overdepths, trenches shall be backfilled to the ground surface with selected material as hereinafter specified. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified or the condition shall be restored to its original condition as near as practicable and as hereinafter specified.
- B. Backfilling lower portion of trench: No. 14 sand shall be deposited in 6-inch maximum thickness layers and compacted with suitable tampers to the specified density and graded as hereinafter specified until there is a cover of not less than one foot over other utility lines unless detailed otherwise. If any portion of the cover in the lower portion of the trench is in the depth of special compaction and materials requirements under pavement, the special requirements shall control. Special care shall be taken not to damage the coating or wrapping of conduit.
- C. Backfilling remainder of trench: Except for special materials for pavements, the remainder of the trench shall be backfilled with excavated material that is free of stones larger than three inches or one-half the layered thickness, whichever is smaller, in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified hereinafter and each layer shall be compacted to the minimum specified hereinafter as applicable to the particular area.
- D. Backfilled under Roadways, Parking Areas and Walks: Six inch layers, at least 95% of maximum density at moisture contents ranging from 1% below to 4% above optimum up to the elevations at which the requirements for pavement subgrade materials and compaction control.
- E. Trenches within the building: Entire trench shall be backfilled with No. 14-2 sand in six inch layers to subgrade line for capillary water barrier.

- F. Under sodded or seeded areas: Twelve inch layers, at least 88% of maximum density at moisture contents ranging from 1% below to 4% above optimum up to the elevation at which topsoil requirements control.
- G. Topsoil placement: Placement and depth as indicated on the drawings or described herein. Contractor shall overfill by 20% to allow for settlement.

3.05. TESTS

- A. Tests for and Control of Density: Tests for determination of maximum density and optimum moisture shall be the responsibility of the Electrical Contractor and shall be performed by the Testing Agency in accordance with the requirements of ASTM D698 Standard Proctor maximum dry density. Samples shall be representative of the materials to be placed. An optimum moisture-density curve shall be obtained for each principal type of material or combination of materials encountered or utilized. Results of these tests shall be the basis of control for compaction. The above testing shall include Atterberg limits, grain size determinations and specific gravity.
- B. Test for Density Control: The Testing Agency will control the density of the backfill by test made in accordance with ASTM Standard D1556. A density test shall be made for each foot of fill for each 200 lineal feet or less of trench. The Contractor shall make as many additional tests as he requires to obtain the specified density at all points.

3.06. PAVEMENT REMOVAL AND REPLACEMENT

- A. Where construction requires cutting and replacing of flexible pavement, cutting shall be so accomplished that the remaining exposed edges shall conform vertically and horizontally to a straight line. Width of the section of pavement removed shall be of necessary width for proper laying of pipe or duct. After the pavement is removed to its full depth, the surface course shall be cut back one foot on both sides of the trench with a concrete saw to provide a true joint in the surface courses. Pavement removed shall be replaced to the same section, materials and compaction as the original pavement. Waste materials shall be disposed of by the Contractor offsite at his own expense and responsibility.
- B. Where construction requires removal and replacement of rigid pavement, the cutting shall be accomplished by a concrete saw, minimum depth of vertical cut shall be one inch. The remaining depth of section may be broken out in any approved manner. Width of section removed shall be such that no area of pavement removed or replaced and no adjacent slab or portion of slab which remains in the pavement abutting the replacement slab shall have length or width between joints of less than 10 feet. Pavement removed shall be replaced to the same section using Class E concrete. Concrete rubble resulting from the above operations shall be disposed of offsite at the Contractor's expense and responsibility.

END OF SECTION

SECTION 26 05 53 – IDENTIFICATION OF ELECTRICAL SYSTEMS

Part 1 **GENERAL**

1.01 RELATED WORK

- A. General Provisions: Section 26 05 01
- B. Painting: Section 26 05 64

1.02 SUBMITTALS

- A. In accordance with Specifications Section 26 05 01, General Provisions, submit manufacturer's data on labels. Include a listing of labels ordered with name of equipment or control device.

1.03 IDENTIFICATION

A. Labeling

1. Label all electrical equipment or controls provided or connected by Electrical Contractor by means of engraved laminated plastic plates screwed or riveted to the devices. Height of letters not to be less than 1/4" unless otherwise specified or directed.
2. Items to be labeled shall include, but not be limited, to the following:
 - a. All motor starters, contactors, safety switches, relays, etc.
 - b. All remote pushbutton stations
 - c. Remote control and specialty switches for lights, etc.
 - d. All motors which cannot be readily identified by their starter label when observer is standing at the motor.
 - e. All main switches or circuit breakers
 - f. All panelboards shall be labeled on outside of door with both source and destination. All final destinations shall be labeled with the source. Example: Panel "A" 120/208V-3PH-4W fed from panel "MDP" via "HC-1".
 - g. Panelboard circuit identification cards shall be typewritten.
 - h. Relay cabinets
 - i. Automatic transfer equipment
3. Printed card labels may be used on items of equipment furnished with plastic windows. Labeling of card shall be neatly printed using lettering device such as a Leroy Instrument.
4. Embossed, adhesive tape labels are not permitted.
5. Panelboards:
 - a. New Directories: filled in complete (Typewritten) listing each circuit and respective equipment served and rooms where outlets, lights, etc., are located.
 - b. Existing Panelboard Directories: completely retyped; revised to include circuits and equipment added and revised with this contract. Contractor shall verify each existing branch circuit and properly identify on new panelboard directory.

6. In addition, all concealed junction and/or pull boxes shall be painted to match the color code of the conduit system to which they are connected and shall be labeled legibly by hand in permanent ink to indicate the panel and circuit numbers which are contained within the junction and/or pull box.
7. Raceway: all raceways both exposed and concealed above accessible ceilings shall be labeled to identify contents. Weatherproof adhesive type labels shall be applied a minimum of every 10'-0" or as required to provide at least one (1) label within each space or room.
8. Wiring and cabling: Systems wiring and cabling not run in conduit shall be tie wrapped and labeled a minimum of every 10'-0" or as required to provide at least one label within every space. Labels for various cable systems shall be grouped together in each location to provide ease of system identification.
9. Examples of system abbreviations/labels shall be as follows: (Note: this list may not be all inclusive.)

<u>Raceway</u>	<u>Label</u>
Power Circuits	"Danger" (voltage contained; normal power black letters; emergency power red letters)
Fire Alarm System	"FA"
Tele/Data System	"TD"

Part 2 **EXECUTION**

NOT USED

Part 3 **EXECUTION**

NOT USED

END OF SECTION

SECTION 26 05 64 - PAINTING

Part 1 **GENERAL**

1.01 **WORK INCLUDED**

- A. Provide all labor, materials and equipment necessary for painting of electrical conduit systems, supports and of other surfaces specified herein. All painting shall be performed by a trade responsible for this type of work.
- B. The following surfaces shall be painted.
 - 1. All interior and exterior exposed conduit, wiremold, boxes, etc.
 - 2. All non-galvanized hangers, platforms, supports and miscellaneous steel
- C. Conduit systems shall be color coded within mechanical rooms, fan rooms and electrical rooms as follows:

<u>COLOR</u>	<u>PORTER PAINT</u>	<u>COLOR NUMBER (USE FOR COLOR MATCH)</u>
Power and lighting (120/208V)	Pampas Sand	11490-2
Power and lighting (277/480V)	International Orange	2463
Fire alarm	Safety Red	4119
Low voltage/Communication	White	_____

- D. The following items shall not be painted:
 - 1. Switches, receptacles and plates
 - 2. Equipment with factory finish
 - 3. Equipment motors and nameplates
 - 4. Concealed conduit and equipment

1.02 **CERTIFICATE**

Submit to Engineer, prior to any approvals of start of any work, a schedule of the exact materials proposed for each application on all surfaces.

1.03 **GENERAL REQUIREMENTS**

- A. All surfaces to be painted shall be clean and dry.
- B. Do not paint surfaces which are non-ferrous metals such as brass or bronze and those items which have a factory finish.
- C. Submit color samples for Owner approval.

1.04 **SUBMITTALS**

- A. Furnish three (3) samples of each type finish and color to Engineer for approval.
- B. LEED Submittals
 - 1. Product Data for Credit EQ4.2: for paints and coatings, including printed

- statement of VOC content.
2. Laboratory Test Reports for Credit EQ4: for paints and coatings, documentation indicating that they meet the testing and product requirements of the California Department of Health Services" "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".
 3. Samples for Initial Selection: for each type of finish-coat material indicated.
 4. Samples for Verification: for each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
 - a. Provide stepped Samples, defining each separate coat, including block filters and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 - b. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
 - c. Submit three samples on the following substrates for review of color and texture only.

1.05 DELIVERY

All paint shall be delivered to the site in manufacturer's sealed containers. Each container shall be labeled with the manufacturer's labels and shall give manufacturer's name, type of paint, color of paint and instructions for reducing. Thinning shall be done only in accordance with directions of manufacturer. Job mixing, or job tinting may be done when approved or directed by Owner's Engineer.

Part 2 **PRODUCTS**

2.01 ACCEPTABLE PAINT MANUFACTURERS

- A. Porter Paint Company/Pittsburgh Paint (PPG)
- B. Sherwin Williams
- C. Glidden Coatings and resins, Division of ICI Corporation
- D. Benjamin Moore and Co.
- E. M.A. Bruder Co. (MAB)

2.02 QUALITY ASSURANCE

Materials of all kinds shall be first line products and of the best quality and of brands approved by the Engineer. All paint shall be delivered in original containers with unbroken seals, plainly marked with manufacturer's name and the trade name or brand, to be opened and used only after approval and applied strictly in accordance with the manufacturer's recommendations with no substitutions.

Part 3

EXECUTION

3.01.

PREPARATION

- A. Steel and Iron: Remove grease, rust, scale and dust by wire brushing and washing and touch up any chipped or abraded places on items that have been shop coated. Where steel and iron have heavy coating of scale, it shall be removed by a wire brushing or as necessary to produce a satisfactory surface for painting.
- B. Before painting, remove and protect hardware, accessories, plates, lighting fixtures and similar items and replace same upon completion of area. Protect adjacent surfaces during work. Damage to or spillage upon adjacent work shall be repaired and/or cleaned and returned to a finished area.
- C. Apply paint to clean, dry and smooth surfaces only. Apply paint smoothly, worked out evenly and allow to dry a minimum of 48 hours before subsequent coats are applied. Protect from dampness. Do not apply exterior paint in damp, rainy weather or until surface has dried thoroughly. Do not apply any paint when temperature is below 50°F. Avoid painting surfaces while surfaces are exposed to hot sun.
- D. Finished work shall be completely covered, be uniform, smooth and free of runs, sags, clogging or excessive flooding. Make edges of paint adjoining other materials or colors sharp and clean with no overlaps. Use masking where required.
- E. At completion, touch up and restore finish where damaged and leave in good condition.

3.02.

STORAGE

- A. A lockable area will be assigned for storing and mixing paints. The floor of this place shall be covered with an approved reinforced, kraft building paper and then with tarpaulins. No mixing shall be done in rooms or spaces other than those assigned for such purpose.
- B. Take all necessary precautions to prevent fire, explosions and other damage. All rags and paint or solvent must be stored in closed metal containers at all times.

3.03.

SCHEDULE OF PAINTING AND FINISHING

- A. Interior and Exterior Bare Ferrous Metal
 - 1. First Coat: Porter No. 296 glyptex rust inhibitive primer
 - 2. Second Coat: Porter No. 2909 acrylic gloss enamel
 - 3. Third Coat: Porter No. 2909 acrylic gloss enamel
- B. Interior non-ferrous metal
 - 1. First Coat: Porter No. 296 glyptex rust inhibitive primer
 - 2. Second Coat: Porter No. 439 glyptex interior enamel
 - 3. Third Coat: Porter No. 439 glyptex interior enamel

- C. Exterior non-ferrous metal
 - 1. First Coat: Porter No. 296 glyptex rust inhibitive primer
 - 2. Second Coat: Porter No. 619 acrylic gloss exterior house paint
 - 3. Third Coat: Porter No. 619 acrylic gloss exterior house paint
- D. Interior galvanized metal
 - 1. First Coat: Porter No. 215 acrylic rust screen primer
 - 2. Second Coat: Porter No. 439 glyptex interior enamel
 - 3. Third Coat: Porter No. 439 glyptex interior enamel
- E. Exterior galvanized metal
 - 1. First Coat: Porter No. 290 galvanized metal primer
 - 2. Second Coat: Porter No. 619 acrylic gloss exterior house paint
 - 3. Third Coat: Porter No. 619 acrylic gloss exterior house paint
- F. Interior PVC Pipe:
 - 1. First Coat: Porter No. 1129 acrylic primer
 - 2. Second Coat: Porter 1119 silken touch velvet
 - 3. Third Coat: Porter 1119 silken touch velvet
- G. Exterior PVC pipe:
 - 1. First Coat: Porter No. 515 bonding primer
 - 2. Second Coat: Porter No. 1119 silken touch velvet
 - 3. Third Coat: Porter No. 1119 silken touch velvet

3.04. CLEANING AND PROTECTION

- A. Any materials of other trades damaged to such extent that they cannot be restored to their original condition shall be replaced by this Contractor at his own expense.
- B. Protect adjacent work and materials by suitable coverings during progress of work. Remove all splattering from floors and other surfaces. Leave work in a clean, orderly acceptable condition.

END OF SECTION

SECTION 26 05 73 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 **GENERAL**

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1.03 WORK INCLUDED BUT SPECIFIED ELSEWHERE

A. Commissioning of Building Systems: Section 01 91 01

1.04 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.05 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 **PRODUCTS**

2.01 **COMPUTER SOFTWARE DEVELOPERS**

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. CGI CYME.
 - 2. SKM Systems Analysis, Inc.
 - 3. Easy Power

2.02 **COMPUTER SOFTWARE PROGRAM REQUIREMENTS**

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 **EXECUTION**

3.01 **EXAMINATION**

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02

POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.03

FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Medium-voltage controller.
 - 3. Motor-control center.
 - 4. Distribution panelboard.
 - 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04

COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P- 32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.

- F. Completed data sheets for setting of overcurrent protective devices.

3.05 ARC FLASH BOUNDARY ANALYSIS

- A. Determine the arc flash boundary for medium voltage switchgear, unit substations, distribution switchboards and panelboards to determine the energy exposure in accordance with NFPA 70E.2004.
- B. Provide and install labels to indicate level of hazard in accordance with NFPA 70E-2004. Install labels on each piece of equipment.

3.06 CORRECTIVE MEASURES

Electrical Contractor shall correct all identified problem areas prior to project acceptance. Review all problem areas and proposed corrective actions with the Engineer prior to corrective actions being implemented.

END OF SECTION

SECTION 26 08 01 – PERFORMANCE TESTING

Part 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Grounding and Bonding Electrical Systems: Section 26 05 26
- D. Low Voltage Distribution Transformers: Section 26 22 13
- E. Switchboards: Section 26 24 14
- F. Panelboards: Section 26 24 16
- G. Wiring Devices: Section 26 27 26
- H. Low Voltage Circuit Protective Devices: Section 26 28 00
- I. Low Voltage Controllers: Section 26 29 00
- J. Fire Detection and Alarm System: Section 28 31 00

1.02 SCOPE OF WORK

- A. Complete testing of all systems as herein specified in the presence of the Architect/Engineer and/or Owners agent. All testing shall be completed by a NETA (National Electrical Testing Association) Certified Independent Testing Contractor.
- B. Electrical Contractor shall be responsible for documenting all performance test results for submittal to the Engineer, Owner. Insert final report in the maintenance manuals.
 - 1. All testing procedures and forms shall be submitted during the submittal process. The forms will detail the Contractor's testing plan with actual equipment, feeders, system details, to be tested. The forms shall be completely filled out prior to testing. This submission is the Contractor's detailed plan as to which piece of equipment on this project is being tested. The test forms shall be specific to this project. Generic test forms will not be accepted.
- C. Scheduling of tests shall be as required for timely completion of construction but with as much consideration as possible for the Owner, Engineer and Construction Manager. A minimum of 72 hours notice shall be given before any scheduled tests.
- D. Testing whenever possible shall be undertaken only on completed systems. Partial system testing shall be acceptable only with prior approval of the Engineer and the Owner. Test results of partial tests shall be submitted at the time of test and also be included in the final system test reports.
- E. Testing of systems as listed herein shall be in accordance with industry standards, practices and recommendations.

Part 2 **PRODUCTS**

NOT USED

Part 3 **EXECUTION**

3.01. **TESTING PROCEDURES**

- A. Electrical Wiring (600V and less feeder cables only)
 - 1. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with single line diagram.
 - b. Test cable mechanical connections to manufacturer's recommended values with a calibrated torque wrench.
 - c. Check cable color coding with applicable Engineer's specifications and National Electric Code Standards.
 - 2. Electrical Tests
 - a. Perform insulation resistance test on each feeder conductor with respect to ground and adjacent conductor. Applied potential to be 1000 volts dc for 1 minute.
 - b. Perform continuity test to insure proper cable connection.
 - 3. Test Values: minimum insulation resistance values shall be not less than two megohms.
 - 4. List all feeder cables to be tested and submit the forms prior to actual testing. The forms must be approved by the Engineer.
- B. Panelboards (Circuit Breakers)
 - 1. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
 - 2. Operate circuit breaker to ensure smooth operation.
 - 3. Inspect case for cracks or other defects.
 - 4. Check tightness of connections with calibrated torque wrench. Refer to manufacturer's instruction.
 - 5. Record phase to phase, phase to neutral voltages and panelboards full load current.
 - 6. Provide a thermographic survey of each panelboard in accordance with Specifications Section 26 08 02, Thermographic Surveys of Electrical Systems.
 - 7. List all panel boards, switchgear, fused switches and circuit breakers to be tested. Submit the forms prior to actual testing. The forms must be approved by the Engineer.
- C. Wiring Devices: Test receptacles with Woodhead #1750 or Hubbell #5200 Tester for proper connection of ground wire and correct polarity. . List all receptacles to be tested within a circuit grouping. All receptacles shall be tested, but circuit grouping reports only are required.

D. Motor Starters:

1. Inspect for physical damage, proper anchorage and grounding.
2. Compare equipment nameplate data with design plans or starter schedule.
3. Motor Running Protection
 - a. Compare overload heater rating with motor full load current rating to verify proper sizing. Record heater rating.
 - b. If power factor correction capacitors are connected on the load side of the overload heaters, include the capacitive reactance in determining proper overload heater size.
 - c. If motor running protection is provided by fuses, verify proper rating considering motor characteristics and power factor correction capacitors if applicable.
 - d. Check tightness of bolted connections.
4. Record phase to phase voltages and running load amperage for each starter.
5. Check all motors for correct rotation. The Electrical Contractor shall be available during operation of the balancing and adjusting mechanical systems and shall make such changes in wiring, heater sizes and other adjustments as are required to permit proper balancing of the systems.
6. List all motor and motor starters to be tested and submit forms prior to actual testing. The forms must be approved by the Engineer.

E. Safety Switches

1. Inspect for physical and mechanical condition.
2. Compare equipment nameplate information with latest single line diagram and report discrepancies.
3. Check for proper anchorage and required area clearances.
4. Inspect all doors, panels and sections for paint, dents, scratches and fit.
5. Verify that fuse sizes and types correspond to drawings. Record this information.
6. Perform mechanical operation tests.
7. Check each fuse holder for adequate mechanical support of each fuse.
8. Inspect all bus or cable connections for tightness by calibrated torque wrench method. Refer to manufacturer's instructions.
9. Test all electrical and mechanical interlock systems for proper operation and sequencing.
10. List all safety switches to be tested and submit forms prior to actual testing. The forms must be approved by the Engineer.

F. Switchboards: Refer to Specification Section 26 24 14. Submit test results as specified in this section.

G. Grounding Systems: Refer to Specification Sections 26 05 26. Submit test results as specified in this section.

H. Low Voltage Distribution Transformers: Refer to Specification Section 26 22 13. Submit test results as specified in this section.

- I. Fire Detection and Alarm System. Refer to Section 28 31 00.
 - 1. Test each device and verify proper operation and calibration.
 - 2. Verify sequence of operation for each device in the system.
 - 3. Provide written verification of test.
- J. Pad Mounted Transformers
 - 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical conditions.
 - c. Verify removal of any shipping bracing after final placement.
 - d. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - e. Verify correct liquid level in all tanks and bushings.
 - f. Perform specific inspections and mechanical tests as recommended by manufacturer.
 - g. Verify correct equipment grounding.
 - 2. Electrical Tests
 - a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground with 5000 volts DC test voltage. Test duration shall be for ten minutes with resistances tabulated at 30 seconds, one minute, and ten minutes. Calculate polarization index. Insulation - resistance test values at one minute should not be less than 5000 megohms. Polarization index shall compared to factory test results.
 - b. Perform a turns-ratio test on all no-load tap-changer positions and all load tap-changer positions. Verify that tap setting is as specified. Verify that winding polarities are in accordance with nameplate. Turns-ratio test results shall not deviate more than one/half percent from either the adjacent coils or the calculated ratio.
 - c. Perform insulation power factor/dissipation factor tests on all windings and correct to 20°C in accordance with test equipment manufacturer's instructions. Maximum power factor corrected to 20°C shall be in accordance with transformer manufacturer's published data.
 - d. Perform power-factor/dissipation-factor tests (or hot collar watts-loss tests) on bushings and correct for 20°C in accordance with test equipment manufacturer's instructions. Investigate bushing power factors and capacities that vary from nameplate values by more than ten percent.
 - e. Measure resistance of each high-voltage winding in each no-load tap-changer position. Measure resistance of each low-voltage winding in each load tap-changer position, if applicable. Consult manufacturer if winding-resistance measurements vary more than one percent from adjacent windings.

- f. If core ground strap is accessible, measure core insulation resistance at 500 volts dc. Consult manufacturer if core insulation is less than one megohm.
- g. Remove a sample of insulating liquid in accordance with ASTM D-923. Sample shall be tested for the following:
 - (1) Dielectric breakdown voltage: ASTM D-877 and/or ASTM D-1816.
 - (2) Acid neutralization number: ASTM D-974
 - (3) Interfacial tension: ASTM D-971 or ASTM D-2285.
 - (4) Color: ASTM D-1500
 - (5) Visual Condition: ASTM D-1524
 - (6) Parts per million water: ASTM D-1533. Required on 25 kV or higher voltages and on all silicone-filled units.
 - (7) Measure dissipation factor or power factor in accordance with ASTM D-924.
- h. Remove a sample of insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D-3612.

END OF SECTION

SECTION 26 08 02 – THERMOGRAPHIC SURVEYS

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Performance Testing: Section 26 08 01
- C. Low Voltage Distribution Transformers: Section 26 22 13
- D. Switchboards: Section 26 24 14
- E. Panelboards: Section 26 24 16
- F. Wiring Devices: Section 26 27 26
- G. Low Voltage Circuit Protective Devices: Section 26 28 00
- H. Low Voltage Controllers: Section 26 29 00

1.02 WORK INCLUDED

- A. The Electrical Contractor shall be responsible for providing a thermographic survey of all major pieces of electrical equipment and selected mechanical equipment motors and control panels as required by this specification and the Engineer.

Survey shall be conducted by a certified independent testing contractor.
- B. Equipment to be Thermographed
 - 1. All three phase motors rated 1/2 HP or larger.
 - 2. All mechanical equipment control panels containing starters, contactors, fuse holders, transformers, etc. as follows:
 - a. Packaged air conditioning equipment
 - b. Air cooled condensing units
 - c. Package rooftop chillers
 - d. Chillers
 - e. Boilers
 - 3. Electric equipment as follows:
 - a. Switchboards
 - b. Panelboards
 - c. Contactors
 - d. Transformers
 - e. Safety/disconnect switches (fused and unfused)
- C. Thermographic surveys of all equipment herein specified shall not take place until three (3) months after final acceptance of all electrical systems and occupancy by the Owner. Survey shall be scheduled by the Electrical Contractor at the Owner's convenience.

PART 2: PRODUCTS

NOT USED.

PART 3: EXECUTION

3.01 THERMOGRAPHIC SURVEY

- A. Visual and Mechanical Inspection
 - 1. Inspect for physical, electrical and mechanical condition.
 - 2. Visually inspect for bus alignment
 - 3. Remove all necessary covers prior to scanning.
- B. Equipment to be Scanned: Switchgear, cables, cable and bus connections and circuit breakers
- C. Provide Report Indicating the following:
 - 1. Problem area (location of "hot spot").
 - 2. Indicate temperature rise between "hot spot" and normal or reference area.
 - 3. Indicate cause of heat rise.
 - 4. Indicate phase unbalance, if present.
 - 5. Index of areas scanned.
 - 6. Provide photographs and thermographs of all areas scanned which will be maintained by the Owner as a record document.
- D. Test Parameters
 - 1. Scanning distribution systems with ability to detect 1°C rise between subject area and reference at 30°C.
 - 2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 3. Provide photographs (thermograms) of the deficient area as seen on imaging system.
 - 4. Infrared surveys should be performed during periods of maximum possible loading but not less than forty percent (40%) of rated load of the electrical equipment being inspected.
- E. Test Results
 - 1. Temperature gradients of 1°C to 3°C indicate possible deficiency and warrant investigation.
 - 2. Temperature gradients of 4°C to 15°C indicate deficiency; repair as time permits.
 - 3. Temperature gradients of 16° and above indicate major deficiency; secure power and repair as soon as possible.
- F. Corrective Measures: Electrical Contractor shall correct all identified problem areas prior to project acceptance. Review all problem areas and propose corrective actions with the Engineer prior to corrective actions being implemented.

END OF SECTION

SECTION 26 22 13 – LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Low Voltage Electrical power Conductors and Cables: Section 26 05 19
- D. Grounding and Bonding: Section 26 05 26

1.02 SUBMITTALS

Submit shop drawings and data sheets on each size of transformer in accordance with Specification Section 26 05 01, General Provisions.

PART 2: PRODUCTS

2.01 GENERAL PURPOSE THREE PHASE TRANSFORMERS (BELOW 30 KVA)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C or rise plus 30°C hot spot = 220°C class.
- C. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations.
- D. Windings: Copper
- E. Impedance: not less than 5.0%
- F. Terminal Boards: to be provided on all units.
- G. Connections: 480V-120/208V (delta/wye).
- H. Taps: 2-5% full capacity below normal or 6-2-1/2% full capacity (2 above and 4 below normal)
- I. Overload Capacity: not less than 10% for intermittent operation.
- J. Size: KVA as indicated on the drawings.
- K. Sound Rating: not greater than 45 db up to and including 25 KVA
- L. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- M. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.

- N. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

2.02 GENERAL PURPOSE THREE PHASE TRANSFORMERS (30 KVA AND ABOVE)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C or rise plus 30°C hot spot = 220°C class.
- C. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations.
- D. Windings: Copper
- E. Impedance: not less than 3.5%
- F. Terminal Boards: to be provided on all units.
- G. Connections: 480V-120/208V (delta/wye).
- H. Taps: two 2-1/2% full capacity above normal; four 2-1/2% full capacity below normal.
- I. Overload Capacity: not less than 10% for intermittent operation.
- J. Size: KVA as indicated on the drawings.
- K. Sound Rating: not greater than 50 db up to and including 150 KVA; not greater than 55 db up to and including 300 kva and not greater than 60 db up to 500 kva.
- L. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- M. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- N. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

2.03 THREE PHASE K-FACTOR RATED TRANSFORMERS (BELOW 30 KVA)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C rise plus 30°C hot spot = 220°C class.
- C. K-Factor Ratings:
K4 = 100% linear load/50% non linear load (panel with 50% computers)
- D. Windings: Copper
- E. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations. The neutral conductor shall be rated to carry 200% of normal phase load.

- F. Impedance: not less than 3.0%
- G. Terminal Boards: to be provided on all units.
- H. Connections: 480V-120/208V (delta/wye).
- I. Taps: 2-5% full capacity below normal or 6-2-1/2%. Full capacity (2 above and 4 below normal)
- J. Overload Capacity: not less than 10% for intermittent operation.
- K. Size: KVA as indicated on the drawings.
- L. Sound Rating: not greater than 45 db up to and including 25 KVA.
- M. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- N. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- O. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

2.04

THREE PHASE K-FACTOR RATED TRANSFORMERS (30 KVA AND ABOVE)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C rise plus 30°C hot spot = 220°C class.
- C. K-Factor Ratings:
K4 = 100% linear load/50% non linear load (panel with 50% computers)
- D. Windings: Copper
- E. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations. The neutral conductor shall be rated to carry 200% of normal phase load.
- F. Impedance: not less than 3.3%
- G. Terminal Boards: to be provided on all units.
- H. Connections: 480V-120/208V (delta/wye).
- I. Taps: 2-1/2% full capacity below normal; four 2-1/2% full capacity below normal
- J. Overload Capacity: not less than 10% for intermittent operation.
- K. Size: KVA as indicated on the drawings.
- L. Sound Rating: not greater than 50 db up to and including 150 KVA; not greater than 55 db up to and including 300 kva and not greater than 60 db up to 500 kva.

- M. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- N. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- O. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens

2.05

THREE PHASE SHIELDED ISOLATION TRANSFORMERS (BELOW 30 KVA)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C or rise plus 30°C hot spot = 220°C class.
- C. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations. An aluminum electrostatic shield between primary and secondary windings grounded to the transformer core shall be provided.
- D. Windings: Copper
- E. Impedance: not less than 5.0%
- F. Terminal Boards: to be provided on all units.
- G. Connections: 480V-120/208V (delta/wye).
- H. Taps: 2-5% full capacity below normal or 6-2-1/2%. Full capacity (2 above and 4 below normal)
- I. Overload Capacity: not less than 10% for intermittent operation.
- J. Size: KVA as indicated on the drawings.
- K. Sound Rating: not greater than 45 db up to and including 25 KVA.
- L. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- L. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- M. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

2.06 THREE PHASE SHIELD ISOLATION TRANSFORMERS (30 KVA AND ABOVE)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C or rise plus 30°C hot spot = 220°C class.
- C. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations. An aluminum electrostatic shield between primary and secondary windings grounded to the transformer core shall be provided.
- D. Windings: Copper
- E. Impedance: not less than 3.5%
- F. Terminal Boards: to be provided on all units.
- G. Connections: 480V-120/208V (delta/wye).
- H. Taps: two 2-1/2% full capacity above normal; four 2-1/2% full capacity below normal.
- I. Overload Capacity: not less than 10% for intermittent operation.
- J. Size: KVA as indicated on the drawings.
- K. Sound Rating: not greater than 50 db up to and including 150 KVA; not greater than 55 db up to and including 300 kva and not greater than 60 db up to 500 kva.
- L. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- M. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- N. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

2.07 SINGLE PHASE TRANSFORMERS (BELOW 30 KVA)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C or rise plus 30°C hot spot = 220°C class.
- C. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations.
- D. Windings: Copper
- E. Terminal Boards: to be provided on all units 7-1/2 KVA capacity or larger.
- F. Connections: 480V-120/208V
- G. Taps: none
- H. Overload Capacity: not less than 10% for intermittent operation.
- I. Size: KVA as indicated on the drawings.
- J. Sound Rating: not greater than 50 db up to and including 25 KVA.
- K. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- L. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- M. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

2.08 SINGLE PHASE TRANSFORMERS (30 KVA AND ABOVE)

- A. Dry type, air insulated and air cooled.
- B. Insulation:
40°C ambient plus 150°C or rise plus 30°C hot spot = 220°C class.
- C. Cores: high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each laminations.
- D. Windings: Copper
- E. Terminal Boards: to be provided on all units 7-1/2 KVA capacity or larger.
- F. Connections: 480V-120/208V
- G. Taps:
 - 1. Two 2-1/2% full capacity below normal
 - 2. Two 2-1/2% full capacity above normal
- H. Overload Capacity: not less than 10% for intermittent operation.
- I. Size: KVA as indicated on the drawings.
- J. Sound Rating: not greater than 50 db up to and including 150 KVA.
- K. Cabinets: sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
- L. Nameplate: all transformers to have metal or plastic nameplate listing manufacturer's name, serial number, type, class, KVA, voltage, frequency and showing an internal wiring diagram.
- M. Manufacturers: General Electric; Hevi-Duty; Jefferson; Precision; Cutler Hammer/Westinghouse; Sorgel; Siemens.

PART 3: **EXECUTION**

3.01 TRANSFORMER INSTALLATION

- A. Unless otherwise indicated on the drawings, all dry type transformers up to and including 75 KVA shall be mounted on rigid steel platform suspended from building structure by means of steel rods or brackets. Verify structural requirements with Structural Engineer and provide additional supports framing as required for proper installation.

- B. Transformers above 75 KVA shall be floor mounted, unless otherwise indicated on the drawings.
- C. Mount all transformers on Korfund Electro-Rib 1" thick vibration eliminators loaded to 50# per square inch. Provide this vibration eliminator even if transformer is internally isolated.
- D. Conduit connections to transformers shall be liquid tight flexible.

3.02

TRANSFORMERS - TESTING (DRY TYPE)

A. Visual and Manual Inspection

- 1. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
- 2. Compare equipment nameplate information with latest single line diagram and report discrepancies.
- 3. Check tightness of accessible bolted electrical joints in accordance with National Electrical Testing Association Standards.
- 4. Perform specific inspections and mechanical tests as recommended by manufacturer.
- 5. Make a close examination for shipping brackets or fixtures that may not have been removed during original installation. Ensure resilient mounts are free.
- 6. Verify proper core grounding.
- 7. Verify proper equipment grounding.
- 8. Verify unit is clean and dry prior to testing.

B. Electrical Tests

- 1. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a megohmmeter with test voltage output as recommended by manufacturer and National Electric Testing Association. Test duration shall be for 10 minutes with resistance tabulated at 30 seconds, 1 minute and 10 minutes. Dielectric absorption ratio and polarization index will be calculated.
- 2. Perform a turns ratio test between windings at all tap settings.
- 3. Perform winding resistance tests for each winding at nominal tap position.
- 4. Perform individual excitation current tests on each phase in accordance with established manufacturer's procedures.
- 5. Verify that the tap-changer is set at specified ratio.
- 6. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading.

END OF SECTION

SECTION 26 24 14 - SWITCHBOARDS

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Performance Testing: Section 26 08 01
- C. Raceways and Boxes for Electrical Work: Section 26 05 33
- D. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- E. Panelboards: Section 26 24 16
- F. Low Voltage Controllers: Section 26 29 00
- G. Low Voltage Circuit Protective Devices: Section 26 28 00
- H. Electricity Metering: Section 26 27 13
- I. Grounding and Bonding for Electrical Systems: Section 26 05 26

1.02 SUBMITTALS

Submit shop drawings in accordance with Specification Section 26 05 01.

1.03 CHARGES BY LOCAL UTILITY COMPANY

Obtain from local utility company, Duke Energy (800) 774-1202, an estimate of the billable expenses that the utility company expects to incur on this project and include this price in your bid. The successful bidder shall pay these charges.

PART 2: PRODUCTS

2.01 SWITCHBOARD

- A. Switchboard shall be dead front type, completely metal enclosed, self-supporting structure independent of wall supports. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard 90" high incorporating switching and protective devices of the number, ratings and type noted herein with all necessary interconnections, instrumentation and control wiring. Switchboard construction shall be of the universal frame type using die-formed members bolted and braced in such a manner that the bolts which will not loosen during shipment. The sides, top and rear shall be covered with removable screw-on plates having formed edges all around. Front plates shall be sectionalized and removable. All front plates shall be fabricated from code gauge steel and shall have formed edges all around. Ventilation openings shall be provided where required. All covers shall be secured by self-tapping screws. Switchboard shall be Class I.
- B. The bus shall be silver plated copper of sufficient size to limit the temperature rise to 65°C based on UL tests and adequately braced and supported to withstand mechanical forces exerted during short circuit conditions.

- C. Small wiring, necessary fuse blocks and terminal blocks for instrumentation within the switchboards shall be furnished. All groups of control wires leaving the switchboards shall be provided with terminal blocks with suitable numbering strips. All hardware used on conductors shall have a high tensile strength and an anti-corrosive zinc plating. Provide the following switchboard instrumentation:
 - 1. Voltmeter with selector switch
 - 2. Ammeter with selector switch
 - 3. Current transformer
 - 4. Potential transformers (277/480V only)
 - 5. Ground fault protection on main device
- D. A ground lug shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. A ground lug shall be furnished attached to the ground bus in a convenient location.
- E. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position.
- F. A-B-C type bus arrangement, left-to-right, top-to-bottom, and front-to-rear, as viewed from the front, shall be used throughout.
- G. Utility company metering compartment shall be provided as required on the incoming line section.
- H. Each switching and protective device shall be provided with visible means of ON-OFF identification. All terminals shall be of the anti-turn solderless type suitable for Cu or Al cable of sizes indicated.
- I. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray baked enamel over a rust-inhibiting phosphatized coating.
- J. Switchboard shall utilize individual fused switches or circuit breakers as required with sections having whatever depth is necessary to accommodate and connect the equipment. All vertical sections shall align front or rear.
- K. All devices, main and feeders, shall be front accessible and shall be individually mounted.
- L. Main horizontal bus bars shall be mounted on glass polyester insulators with all three phases arranged in the same vertical plane. The main bus shall have a maximum ampacity of 1600 amperes and shall be braced for short circuits up to 100,000 amperes. Main bus splices shall be supplied between adjacent distribution sections.
- M. Switchboard shall bear UL labels. Designs shall meet NEC and NEMA standards as well as OSHA requirements.

2.02

CIRCUIT BREAKERS - MOLDED CASE

- A. These units shall be single or multi-pole as required and shall have a quick-make, quick-break mechanism.

- B. Breakers shall have overload elements of the thermal magnetic type that provides inverse time delay and instantaneous short circuit protection. Each pole of a breaker shall contain an overload element. Multi-pole units shall have a common tripping mechanism. Breakers rated 250 amps and above shall have adjustable trip units. Trip setting shall be as indicated on the drawings.
- C. Breakers shall have a toggle type handle with three positions indicating "on", "off" or tripped". A breaker tripping on overload shall be clearly indicated by the handle assuming a midway position between "on" and "off".
- D. All breakers shall be bolt-in type and shall be full size single units.
- E. Trip rating and other interrupting requirements shall be as shown on the drawings. Minimum interrupting capacity shall be 30,000 amps.
- F. Manufacturers: Siemens; Square D; General Electric; Challenger; Cutler-Hammer/Westinghouse

2.03

FUSIBLE SWITCHES - BRANCH FEEDERS

- A. Fusible switches for branch circuit feeders shall be 2 or 3 pole as indicated with fuse holder sized to accept the proper fuse for the ampacity of the circuit.
- B. Operating mechanism shall be quick-make, quick-break with an externally operated handle which can be locked in the "off" position.
- C. Units shall be mounted in metal enclosure and be removable from the front of switchboards without disturbing adjacent units or bus structure.
- D. Units which are to utilize current limiting fuses shall be equipped with rejection clips which will prevent other type fuses from being installed.
- E. Manufacturers: Siemens; Square D; General Electric; Challenger; Cutler-Hammer/Westinghouse

2.04

MAIN FUSIBLE SWITCHES

- A. Fusible switches for main service entrance shall be bolted pressure, load break type with mechanism for dead front operation. Ratings shall be as indicated on the drawings. Fuse holders shall accommodate the amp rating and class of fuse indicated on the drawings.
- B. Operating mechanism shall be stored energy type to provide quick positive switching action independent of the speed at which the handle is operated. Switch shall be closed by manual operation of the handle and opened by mechanical or electrical push button. The operating handle shall be interlocked with the fuse access door and have provisions for padlocking in the "open" position.
- C. These units shall be equipped with the following:
 - 1. Electrical trip push button
 - 2. Ground fault protective device
 - 3. Blown fuse detector
 - 4. Phase failure protection
 - 5. "Charged - Closed" signal device

D. Manufacturers: Pringle; Square D; Kelek

2.05

MAIN CIRCUIT BREAKERS

A. Individually fixed mounted

1. Circuit breaker(s) shall have power terminals to accommodate either cable or bolted bus connections.
2. Circuit protective devices shall be two-step stored energy type circuit breaker, they shall be UL listed for 100% continuous current.
3. Provide a fixed instantaneous (High Level Selective Override) circuit on breaker(s). The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrents below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
4. Circuit breaker(s) shall utilize a glass reinforced insulating material providing high dielectric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area. Breaker(s) shall have common tripping of all poles and shall be trip free. The breaker(s) shall have quick-make, quick-break contacts with a maximum 5 cycle closing time.
5. Circuit breaker(s) shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
6. Breaker faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
7. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.
8. Provide true two-step stored energy mechanism for 5 cycle closing. Energy required to close breaker shall be stored pending release to close action. All circuit breakers shall have multiple CHARGE/CLOSE provisions allowing the following sequence: CHARGE, CLOSE RECHARGE, OPEN/CLOSE/OPEN.
9. Furnish local control push buttons to OPEN and CLOSE circuit breaker. Color coded visual indication of contact position (OPEN or CLOSED) shall be provided on the front of breaker. Provide for local manual charging following CLOSE operation. Color-coded visual indication of mechanism CHARGED and DISCHARGED position shall be provided on the face of the breaker. Visual indicator shall indicate CHARGED only when closing springs are completely charged.
10. Electrical Operated Circuit Breaker: Main circuit breaker shall be electrically operated to permit remote CHARGE, CLOSE and OPEN capabilities. Electrically operated circuit breaker shall be equipped with charge contact switch for remote indication of mechanism charge status.
11. Electronic Trip System:
 - a. The entire trip system shall be a microprocessor based, true rms sensing design with sensing accuracy through the 13th harmonic. Micrologic full function by Square D or approved equal is acceptable.
 - b. Provide the following time/current curve shaping adjustments to maximize system selective coordination. Each adjustment shall have discrete settings and each function is independent from all other adjustments.

- (1) LIG
Adjustable Long Time Ampere Rating and Delay
Adjustable Instantaneous Pickup
Adjustable Ground Fault Pickup and Delay (Delay includes I2t IN and I2T Out)
- 12. Each circuit breaker trip system is to include an externally accessible test port for use with a Universal Equipment Test Set. Provide one (1) Universal Equipment Test Set for this project job for final inspection. This test set shall be suitable for testing all electric circuit breakers specified for this project. No disassembly of the circuit breaker is required for testing.
- 13. Each SE type circuit breaker trip unit shall be capable of communicating the following data via a high speed network (19.2k Baud).
- 14. Phase current A, B, and C phases and ground fault in real time.
- 15. Switch settings:
 - a. Long-time settings: pickup and delay
 - b. Short time settings: pickup and delay.
 - c. Instantaneous settings
 - d. Ground fault settings: pickup and delay
- 16. Trip History
 - a. Last fault type
 - b. Phase current of A, B and C phases and ground fault indication at time of last trip
 - c. Short circuit pickup
 - d. Overload pickup
 - e. Overload trips (cumulative)
 - f. Short circuit trips (cumulative)
 - g. Ground fault trips (cumulative)
- 17. Equipment Ground Fault Protection
 - a. Circuit breaker(s) shall be provided with integral equipment protection for grounded systems.
 - b. The ground fault system shall be of the residual type.
 - c. Circuit breaker(s) shall be provided with zone selective interlocking (ZSI) on the Ground Fault function in order to limit thermal stress caused by a fault, yet permit optimum coordination with all other electronic trip circuit breakers.
- 18. Terminations
 - a. All lugs shall be UL listed to accept solid and/or stranded copper and aluminum conductors. Lugs shall be suitable for 90°C rated wire, sized according to the 75°C temperature rating in the NEC).
 - b. All circuit breakers shall be UL listed to accept field installable/removable mechanical type lugs.
 - c. All circuit breakers shall be suitable for bus connection.

PART 3: EXECUTION

3.01 INSTALLATION

- A. Switchboard shall be installed on 6" high concrete housekeeping pad where indicated on the drawings.
- B. Installation of switchboard shall meet all NEC and manufacturer's requirements.

3.02 INSPECTION AND TEST PROCEDURES FOR SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

These tests to be conducted by a National Electrical Testing Association Certified Testing Company.

A. Visual and Mechanical Inspection

1. Inspect for physical, electrical and mechanical condition.
2. Compare equipment nameplate information with latest single line diagram and report discrepancies.
3. Verify that circuit breaker sizes and types correspond to drawings.
4. Verify that current and potential transformer ratios correspond to drawings.
5. Inspect all bus connections for high resistance. Use low resistance ohmmeter, or check tightness of bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions or National Electrical Testing Association Standards for proper torque levels.
6. Test all electrical and mechanical interlock systems for proper operation and sequencing.
7. Clean entire switchgear using manufacturer's approved methods and materials.
8. Exercise all active components.
9. Inspect all indicating devices for proper operation.

B. Electrical Tests

1. Perform ratio and polarity tests on all current and voltage transformers.
2. Perform ground resistance test in accordance with Specification Section 26 05 26, Grounding and Bonding.
3. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
4. Perform secondary voltage excitation test on all control power circuits and potential circuits as detailed in Sections 7.1.2.12 and 7.1.2.13. Voltage levels will be checked at each point on terminal boards and at each terminal on devices.
5. Perform current injection tests on the entire current circuit in each section of switchgear.
 - a. Current tests will be made by primary injection, where possible, with magnitudes such that a minimum of 1.0 amp flows in the secondary circuit.
 - b. Where primary injection is impractical, secondary injection shall be utilized with a minimum current of 1.0 amp.
 - c. Incoming and outgoing current will be tested at each device.
 - d. All current transformers will have the following tests performed in accordance with ANSI/IEEE C57.13.1.
 - (1) Determine the burden of the current transformer secondary circuit and saturation level of the current transformer.
 - (2) Test current transformer circuits supplying overcurrent relays to determine proper operation at the relay tap value. Verify that the maximum current deliverable by the CT is not below the maximum value required by the coordination study.

6. Calibrate all meters at midscale. Calibrate watt-hour meters to one-half percent (.05%). Verify multipliers.
7. Control Power and Potential Transformers
 - a. Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - b. Verify proper primary and secondary fuse ratings or circuit breakers as indicated.
 - c. Verify proper interlock function and contact operation.
 - d. Verify taps if applicable and connect transformer to desired tap.
 - e. Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
 - f. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check potential at all devices.

3.03 THERMOGRAPHIC SURVEY OF SWITCHBOARD

- A. Visual and Mechanical Inspection
 1. Inspect for physical, electrical and mechanical condition.
 2. Visually inspect for bus alignment.
 3. Remove all necessary covers prior to scanning.
- B. Equipment to be Scanned: Switchgear, cables, cable and bus connections and circuit breakers.
- C. Provide Report Indicating the following:
 1. Problem area (location of "hot spot").
 2. Indicate temperature rise between "hot spot" and normal or reference area.
 3. Indicate cause of heat rise.
 4. Indicate phase unbalance, if present.
 5. Index of areas scanned.
- D. Test Parameters
 1. Scanning distribution systems with ability to detect 1°C rise between subject area and reference at 30°C.
 2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 3. Provide photographs (thermograms) of the deficient area as seen on imaging system.
 4. Infrared surveys should be performed during periods of maximum possible loading, but not less than forty percent (40%) of rated load of the electrical equipment being inspected.
- E. Test Results
 1. Temperature gradients of 1°C to 3°C indicate possible deficiency and warrant investigation.
 2. Temperature gradients of 4°C to 15°C indicate deficiency; repair as time permits.

3. Temperature gradients of 16°C and above indicate major deficiency; secure power and repair as soon as possible.

3.04 GROUNDING FAULT SYSTEMS (NEC 230-95)

Visual and Mechanical Inspection

- A. Inspect for physical damage and compliance with plans and specifications.
- B. Inspect neutral main bonding connection to assure:
 1. Zero sequence sensing system is grounded
 2. Ground strap sensing systems are grounded through sensing device.
 3. Ground connection is made ahead of neutral disconnect link on zero sequence sensing systems.
 4. Grounded conductor (neutral) is solidly grounded.
- C. Inspect control power transformer to ensure adequate capacity for system.
- D. Monitor panels (if present) shall be manually operated for:
 1. Trip test
 2. No trip test
 3. Non-automatic reset
- E. Proper operation and test sequence shall be recorded.
- F. Inspect zero sequence systems for symmetrical alignment of core balance transformers about all current carrying conductors.
- G. Verify ground fault device circuit nameplate identification and device operation.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Performance Testing: Section 26 08 01
- C. Raceways and Boxes: Section 26 05 33
- D. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19

1.02 WORK INCLUDED

Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein.
Panelboards

1.03 SUBMITTALS

Submit shop drawings for distribution equipment in accordance with Specifications Section 26 05 01, General Provisions.

PART 2 **PRODUCTS**

2.01 PANELBOARDS

- A. Provide panels consisting of an assembly of branch circuit switching and protective devices mounted inside a dead front enclosure. Provide the number, size and arrangement of these branch circuit devices as shown on the drawings. Poles shown on Panel Schedules without circuit description shall be provisions for future protective devices.
- B. Panelboard Interior
 - 1. Rigid removable assembly of copper bus bars and interchangeable bolted branch circuit devices.
 - 2. Bus bars drilled to permit branch circuit devices of all sizes and number of poles to be interchangeable and installed in any spare space of sufficient size, without disturbing adjacent units, removing main bus or branch circuit connectors and without machining, drilling and tapping.
 - 3. Arrange bus in sequence or distributed phasing so that multi-pole circuit breakers can replace any group of single pole circuit breakers of the same size.
- C. Enclosure
 - 1. Code gauge 20" wide (minimum) steel box galvanized after fabrication with turned up peripheral front edge, bolted joints and multiple knockouts on top and bottom.
 - 2. Provide ground bus on inside of tub.

3. Minimum gutter sizes as follows:

<u>Panel Sides</u>	<u>Top and Bottom</u> <u>No Main Lugs</u>	<u>Main Lugs</u>
20 poles or less	4" or 5"	6"
More than 20 poles	6" or 6"	8"
Feed thru cables	8" (one side only)	

4. Flush mounted in finished areas and where indicated. Surface mount elsewhere.

D. Front

1. Provide door in door construction.
2. Heavy code gauge steel reinforced with welded corners on rear as required to maintain panel face flat.
3. Provide lock in stainless steel or brushed chrome finished in door over branch circuit devices (or approved equal). All panels keyed alike. Supply four (4) keys to Owner.
4. Bold front closed with trim clamps.
5. Same size fronts on panels mounted adjacent to other panels or telephone cabinets. Largest required size governs height of all.
6. Factory finished in medium gray baked enamel or two coats of air drying lacquer over a rust inhibitor.

E. Terminals

1. Bolted type, suitable for copper conductors.
2. Locate main lugs properly at top or bottom depending where main feeder enters.

F. Electrical Ratings

1. 120/208 volts, three phase, four wire, full neutral, Type NQ (as manufactured by Square D) or equal unless otherwise noted.
2. 277/480 volts, three phase, four wire, full neutral, Type NF (as manufactured by Square D) or equal unless otherwise noted.

G. Manufacturers: General Electrical, Square D, Siemens, Cutler Hammer

2.02 COLUMN TYPE PANELBOARDS (WHERE SPECIFICALLY NOTED)

- A. Similar in basic construction requirements to panelboards hereinbefore specified, but narrow column type. Minimum gutter space requirement of 4" shall not apply and panel doors may be equipped with standard hinges.
- B. Each panelboard shall be furnished with junction box containing neutral bus, mounted above panelboard and connected to it by means of raceway same cross-sectional dimension as panelboard.
- C. Branches: bolted to bus type circuit breakers as already specified and shown on the drawings.
- D. Manufacturers: General Electric; Square D, Siemens, Cutler-Hammer

2.03 CONTACTOR PANEL SWITCH

- A. Type
 - 1. Single coil, magnetically operated, mechanically locked type without hooks on latches.
 - 2. Mounting: on dampening device or insulated cabinet.
 - 3. Contacts: silver with auxiliary arcing contacts.
 - 4. Lockout relays: to prevent simultaneous operation from two remote locations.
 - 5. Manufacturers: ASCO Type RC, Bulletin 920

2.04 ENERGY METER

- A. Provide energy meters on panelboards as indicated on the drawings.
- B. The energy meter shall provide KWH readings for each panelboard utilizing CT's and provide the information in a backlighted LCD type display.
- C. Unit shall meet ANSI C12.1 metering accuracy requirements.
- D. Manufacturers: Square D Power Logic Energy Meter or approved equal.

PART 3 **EXECUTION**

3.01 PANELBOARD INSTALLATION

- A. Support panel cabinets independently to building structure with no weight bearing on conduits.
- B. Securely anchor surface mounted panelboards to masonry walls with heavy duty machine bolt anchors.
- C. Install recessed panelboards to allow cover to be drawn tight against wall to provide neat appearance.
- D. Install panelboards so top breaker is no higher than 6'-0" above the floor.
- E. Protect panelboards and cabinets during construction to prevent damage and entry of dirt, paint, etc.
- F. Adjacent panel cabinets shall be mounted in horizontal alignment at top.
- G. Wiring inside the equipment, panels and boxes shall be installed in a neat and workmanlike manner.

3.02 BALANCING ELECTRICAL LOAD

Care shall be exercised in connecting various electrical loads to panelboards in order to arrive at reasonable balance between loads on each phase at each panelboard. It will be the responsibility of the Electrical Contractor to make tests and adjust loads at each panelboard to result in a reasonably balanced load condition, satisfactory to the Owner.

END OF SECTION

ICI Warehouse Expansion Project

SECTION 26 27 17 - HANDHOLES

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Grounding and Bonding: Section 26 05 26

PART 2: PRODUCTS

2.01 HANDHOLES

- A. Construction
 - 1. Reinforced concrete 3000#/ft.
 - 2. Sump pit to be provided in floor which shall drain to it.
 - 3. Cover to be Neenah R-1640-R1 or approved equal and marked Electric.
 - 4. Elevation of cover to be adjustable by adding or removing courses of brick.
- B. Pulling-In Irons: provide at locations opposite duct entrance.

2.02 MANUFACTURERS

- A. Oldcastle Precast (formerly Hartford Concrete Products).
- B. Champion Precast

PART 3: EXECUTION

3.01 INSTALLATION

- A. Install handhole level and plumb.
- B. Coordinate exact location and depth with other utilities in the area.
- C. Adjust handhole cover and ring as required for final grade conditions.

END OF SECTION

SECTION 26 27 18 - MANHOLES

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Grounding and Bonding: Section 26 05 26

PART 2: PRODUCTS

2.01 MANHOLES

- A. Construction
 - 1. Reinforced concrete 3000#/ft.
 - 2. Sump pit to be provided in floor which shall drain to it.
 - 3. Cover to be Neenah R-1640-R1 or approved equal and marked Electric.
 - 4. Elevation of cover to be adjustable by adding or removing courses of brick.
- B. Cable Racks
 - 1. Hot dipped galvanized, heavy duty rack consisting of heavy gauge sheet steel piece anchored to wall with four (4) insulation support arms. Insulators to the white glazed saddle type.
 - 2. Provide sufficient cable supports on walls for feeding being installed under this contract, plug additional supports on other walls for future use.
 - 3. Supports for primary cabling (13.8 KV) shall be isolated by a minimum of 12" from all other cable supports.
 - 4. Manufacturers: (Rack): Hubbard #2225; or approved equal
Insulators: Hubbard 32118, or approved equal
- C. Pulling-In Irons: provide at locations opposite duct entrance.

2.02 MANUFACTURERS

- A. Oldcastle Precast (formerly Hartford Concrete Products)
- B. Champion Precast

PART 3: EXECUTION

3.01 INSTALLATION

Install manholes level and true. Coordinate locations with other site utilities.

3.02 GROUNDING

Provide one ¾" x 20'-0" copperweld ground rod driven into earth at an angle away from manhole. Run a #4 solid copper grounding conductor around perimeter of manhole and connect to ground rod. Bond cable racks and #4 ground conductor system run with duct bank.

END OF SECTION

SECTION 26 27 26 – WIRING DEVICES

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Performance Testing of Systems: Section 26 08 01
- C. Raceways and Boxes for Systems: Section 26 05 33
- D. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- E. Floor Boxes: Section 26 27 27

1.02 SUBMITTALS

Submit shop drawings or data sheets on all devices and plates used in accordance with Specification Section 26 05 01, General Provisions.

PART 2: PRODUCTS

2.01 SWITCHES

- A. Specification grade switches shall be single pole, two pole, three way, four way, momentary, lighted or pilot lighted as required to control lights or other device and shall be toggle or key operated, heavy duty, specification grade, 20 amp, 120/277 volt, quiet type and shall meet the requirements of Federal Specifications WS-896-d and NEMA-WD-1. Assembly shall be by screw to mounting bridge. Screw into plastic base or riveting is not acceptable.
 - 1. Manufacturers: (with lighted or pilot handle) Hubbell #1221IL; Hubbell #1221 PL; Pass & Seymour #20AC1-1SL.; Cooper #2221LTV
- B. Where space is limited or when reusing existing switch boxes, "Despard" (twin horizontal switches in single gang arrangement) quiet type, rated 20 amps, may be used.
- C. Weatherproof switches shall be Bryant #4981, Hubbell #HBL1281 Series "Presswitch" with a #HBL1750 grey "Hypalon" coverplate; or Cooper #2991 Switch with a 2881G coverplate. Where a toggle switch is required, provide Hubbell Plate #1795.
- D. Door switches shall be self-restoring type with adjustable plunger on/off. Manufacturer: Edwards #502 or Cooper 1664.
- E. All switches shall have binding post terminals or pre-wired pigtails.

2.02 RECEPTACLES

- A. All receptacles shall be grounding type and shall be Duplex 120 volt, 120/208 volt, single phase, 208/240 volt, 277 volt, single phase or 120/208 volt and 277/480 volt, three phases as scheduled below or as indicated on the drawings.
- B. Heavy duty specification grade duplex receptacles shall be 20 ampere, 125 volts, with impact resistant face, wrap around steel mounted strap, and shall meet the requirements of Federal Specification WC-596-e, NEMA WD-1 and UL-498.
- C. All receptacles in Hospitality Guest Rooms or areas classified as dwelling units shall be tamper resistant in accordance with NEC Article 406.11.
- D. Ground Fault (GFCI) Receptacles
 - 1. Receptacles shall be duplex style with impact resistant face with built-in ground interrupter set to trip out at a 5 milliamp maximum ground fault. Receptacles shall be rated 15 or 20 amperes, standard or feed-through as required.
 - 2. Manufacturers: Hubbell #GF-5262I; Hubbell #GF-5362I; General Electric #TGTR115; General Electric #TGTR115F; Bryant #GFR Series; Pass & Seymour #2091, Leviton 8899; Cooper XGF15; Cooper XGF20
- D. Weatherproof Duplex Receptacles (wet or damp label locations)
 - 1. Weatherproof duplex receptacles shall be 20 ampere, GFCI type with an appropriate weatherproof, UV stabilized polycarbonate or stainless steel gasketed coverplate with hinged lid that will allow cords to be installed while cover is completely closed and/or locked.
 - 2. Manufacturers:
Taymac #20310 - Vertical Mount GFCI
- E. Isolated Ground Devices
 - 1. Duplex units shall be 20 ampere orange faced, specification grade, back side wired.
 - 2. Hubbell Standard CR5252IG/CR5352IG; on single gang installations shall be furnished with nylon, orange plate hot stamped "Isolated Ground"; Hubbell #IGP8 or Pass & Seymour #IG6200/IG6300/Plate #RP8-IG/SRP8-IG; Bryant 5262IG/5362IG; Cooper Wiring Devices #IG5262/IG5362/Plate #IG5132RN
 - 3. Isolated ground twist locks shall be color coded by voltage and orange fronted such as Hubbell IG2310A or Pass & Seymour #IGL520R, Bryant 70520IG.; Cooper Wiring Devices #L520R
 - 4. Heavy duty pin and sleeve devices for non hazardous shall be UL listed watertight. Conform to I.E.C. standards, color coded by voltage, 20A, 30A, 60A, 100A as specified: Hubbell; Pass & Seymour; Bryant, Cooper Wiring Devices

- F. Safety Devices:
1. Duplex units shall be 20 ampere, specification grade, back side wired.
 2. Devices to be designed to prevent accidental shock due to the insertion of a foreign object.
 3. Hubbell HBL8300SG or equal by Pass & Seymour, Bryant or Cooper Wiring Devices.
- G. All receptacles shall have binding post terminals. Provide all wiring devices with pigtail connectors. Connectors consists of a 6" long #12 AWG stranded wire with a #10 fork type brass terminal at one end and a factory attached copper alloy spring type twist-in wire connector at opposite end. Pigtails to be similar to Term-A-Nut by Ideal or equal.
- H. USB Charger Receptacles
1. Design Requirements
 - a. USB charger receptacle shall be a Tamper Resistant duplex TR configuration with two (2) USB ports and two (2) 15 or 20 amp AC power outlets, or with four (4) USB ports, as specified on plans.
 - b. USB port shall be stainless steel construction.
 - c. Device shall be of a Decorator Styleline configuration using standard or midsized decorator wall plates.
 - d. Device shall have an LED to indicate USB power available.
 - e. Device shall have terminals capable of back and side wiring using solid or stranded AWG #14 – 10 gauge wire, for hot, neutral and ground.
 2. Performance Requirements
 - a. USB charger receptacle shall be listed to UL498 and UL1310.
 - b. USB output rating shall be 3.0 amp, 5 VDC
 - c. USB ports shall be rated for 10,000 insertion and withdrawal cycles
 - d. Receptacle rating shall be 15 or 20 amp, 125 volt
 - e. Device shall comply with battery charging specification USB BC 1.2
 - f. Device shall be compatible with USB 1.1/2.0/3.0 devices, including Apple products.
 - g. Device shall comply with Part 16 of the FCC rules.
- I. Schedule of Receptacles, Plugs and Connectors
1. 125 volt, 20 amp, 2 pole, 3 wire grounding

NEMA CONFIGURATION MANUFACTURER	5-20-R HOSPITAL GRADE RECEPT.
Bryant	8300
Hubbell	8300H Hospital Grade Series
Pass & Seymour	8300 Hospital Grade Series
Cooper Wiring Devices	8300H - Compact Series
Cooper Wiring Devices	8300H

2. 125 volt, 20 amp, 2 pole, 3 wire grounding

NEMA CONFIGURATION	5-20R
MANUFACTURER	RECEPT.

a.	Cooper Wiring Devices	5362
b.	Bryant	5362
c.	General Electric	5362
d.	Hubbell	HBL5362
e.	Pass & Seymour	5362A
f.	Leviton	5362a

2. 250 volt, 20 amp, 2 pole, 3 wire grounding

NEMA CONFIGURATION	6-20R	6-20P	6-20R
MANUFACTURER	RECEPT.	PLUG	CONN.

a.	Cooper Wiring Devices	5462	5466N	5469-N
b.	Bryant	5462-I	5466-N	5469-N
c.	General Electric	----	GED0621	GED0623
d.	Hubbell	HBL5462-I	HBL5466-C	HBL5469-C
e.	Pass & Seymour	5862-I	5466-X	5469-X
f.	Leviton	5462	5466	5469

3. 250 volt, 30 amp, 2 pole, 3 wire grounding

NEMA CONFIGURATION	6-30R	6-30P	6-30R
MANUFACTURER	RECEPT.	PLUG	CONN.

a.	Cooper Wiring Devices	1234	5701N	6700N
b.	Bryant	9630-FR	9630-RP	----
c.	General Electric	4139-3	GED0631	GED0633
d.	Hubbell	HBL9330	9331	----
e.	Pass & Seymour	5930	5931	----
f.	Leviton	5372	9630P	----

4. 125 volt, 20 ampere, 2 pole, 3 wire grounding (locking type)

MANUFACTURER	RECEPT.	PLUG	CONN.

Bryant	70520FR	70520NP	70520NC
Pass & Seymour	L5-20R	L5-20P	L5-20C
Hubbell	HBL2310	HBL2311	HBL2313
Leviton	2310	2311	2313
Cooper Wiring Devices	CWL520R	CWL520P	CWL520C

5. 480 volt, 30 ampere, 3 pole, 4 wire grounding

MANUFACTURER	RECEPT.	PLUG	CONN.
Bryant	71630FR	71630NP	71630NC
Pass & Seymour	L16-30R	L16-30P	L16-30C
Hubbell	HBL2730	HBL2731	HBL2733
Leviton	2730	2731	2733
Cooper Wiring Devices	CWL1630R	CWL1630RP	CWL1630C

6. 480 volt, 100 ampere, 3-pole, 4 wire grounding

MANUFACTURER	RECEPT.	PLUG	CONN.	BACKBOX
Bryant	4100R7W	4100P7W	4100C7W	BB1002W
Pass & Seymour	PS4100R7W	PS4100P7W	PS4100C7W	PSBB1001W
Hubbell	4100R7W	4100P7W	4100C7W	BB1001W-1-1/4"
Cooper Wiring Devices	CW4100R7W	CW4100P7W	CW4100C7W	BB1002W-2"

7. Color of Wiring Devices

- All device numbers listed herein are brown.
- All wiring devices in finished areas shall be gray that correspond to catalog numbers hereinbefore specified.
- All wiring devices in exposed boxes shall be gray that correspond to catalog numbers hereinbefore specified.

8. Device Plates

- Provide proper plates on all switches, receptacles, special devices and outlets.
- Plates in finished areas shall be smooth type, impact resistant, flexible material similar to nylon. Phenolic not approved. Color shall be same as the device unless noted otherwise.
- Provide #302 or 304 brushed stainless steel plates for all receptacles in unfinished areas. Brushed finish shall extend to edges of plate including beveled surfaces.
- All general use plates shall be of same manufacturer as devices.
- Provide blank plates on all unused boxes.

2.03 SURFACE METAL RACEWAY

- A The raceway and all the system components must be UL Listed. Finish may be either gray or ivory and shall be suitable for field repainting to match surroundings. Color by Architect.

1. Raceway (4000 Series)

The raceway shall be of a two piece design with a metal base and snap on metal cover. Base shall be a minimum of 0.050 inch wall thickness and cover shall be a minimum of 0.040 inch wall thickness. Assembled base and cover shall be no larger than 4.750 inches wide by 1.750 inches high with a minimum cross section area of 7.50 square inches. Base shall be dividable by means of a removable barrier section into two equal compartments.

2. Raceway (3000)

The raceway shall be a two piece design with a metal base and a snap-on metal cover. The base and cover sections shall be a minimum of 0.040" wall thickness. Assembled base and cover shall be a maximum 2.75" wide by 1.53" high with a minimum cross sectional area of 3.51 square inches. The base section shall be available in 10' lengths and the cover section in 5' and 10' lengths, or custom lengths where required.

- B. A full line of fittings must be available including but not limited to flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fitting and a full compliment of device mounting brackets and plates.
- C. Device brackets shall be available to install single or two gang devices both horizontal or vertical within the raceway. Devices both power and data/communications shall have the capacity of mounting flush or in conjunction with face plates.
- D. A plastic device mounting bracket and trim plate shall be available to install devices horizontally. (4000 Series) Trim plate shall overlap cover eliminating seam. Face plates shall be available to accept a variety of power and data/communications devices. Plastic must be compatible with UL 94 for Plastic Materials.
- E. Manufacturers: Wiremold or approved equal.

2.04 CLOCK RECEPTACLES

- A. 120 volt, 15 amp, 2 pole, 3 wire grounding with heavy duty hook to support clock.
- B. Manufacturers: Hubbell #5235; Bryant #2828-GS; Pass & Seymour #S3733SS; Leviton 5261-CH; Cooper Wiring Devices #93632

2.05 PHOTO CELL

- A. Photocell shall be adjustment type rated 1800 watts at 120 volts.
- B. Housing shall be cast aluminum weatherproof with 1/2" nipple for conduit connection.
- C. Manufacturers: Tork #2101; Paragon #CW201; Intermatic K4121; or approved equal.

2.05 TIME CLOCK

- A. General
 - 1. A 20 ampere electronic seven day, four channel time switch.
 - 2. Turn "ON" initiated by photo cell; can be set 20 or 40 minutes before or after normal sunset to adapt to local area.
 - 3. Turn "OFF" at pre-set time adjustable in half hour increments.
 - 4. Day-omitting feature: switch shall operate every day unless set to omit selected days.
 - 5. Battery backup in the event of a power outage.

- B. Time switch contacts shall be capable of switching 20 amperes per pole continuously at 120 volts and shall be four pole.
- C. "ON" operation shall occur automatically as initiated by the photocell. "OFF" operation shall be adjustable in one half hour increments.
- D. Enclosure shall be NEMA 1 surface type. Enclosure shall be finished in baked epoxy enamel with combination 1/2" and 3/4" knockouts on bottom both sides, top and back. Provision shall be made for positive padlocking and/or sealing.
- E. Terminals shall be of the pressure type capable of receiving #8 AWG wire.
- F. Manufacturers: Tork #DTS400A; Paragon #EC-74; Intermatic ET70415CR; or approved equal.

2.06

ASTRONOMIC TIME CLOCKS

A. General

- 1. A 40 ampere (tungsten) synchronous motor driven time switch with Astronomic dial.
 - 2. Turns "ON" only at sunset; can be set 20 or 40 minutes before or after normal sunset to adapt to local area.
 - 3. Turns "OFF" at sunrise or can be set from 8:30 pm to 2:30 am in half hour increments; no setting for seasonal changes as trippers follow the seasons.
 - 4. Day-omitting feature: switch shall operate every day unless set to omit selected days.
 - 5. Separate manual "ON/OFF" levers enable operation without disturbing automatic settings.
 - 6. Different dials provided for every 140 miles or 2 degrees of north latitude; specify city of use; maximum 47 degree north.
 - 7. Reserve power to keep dial on time for 16 hours in case of power failure (optional).
- B. Time switch contacts shall be capable of switching 40 amperes per pole continuously at 277 volts and shall be DPST, 3PDT or SPDT, as required.
 - C. Enclosure shall be NEMA 1 surface type. Enclosure shall be finished in baked epoxy enamel with combination 1/2", 3/4" knockouts on bottom, both sides and top and back. Provision shall be made for positive padlocking and/or sealing.
 - D. Terminals shall be of the pressure type capable of receiving #8 AWG wire.
 - E. Manufacturers
 - 1. Tork #7200ZL; Paragon #4004-71SZ (DPST) Intermatic T174
 - 2. Tork #7120ZL; Paragon #4006-71SZ (SPDT) Intermatic T175
 - 3. Tork #7300ZL; Paragon #47217-27SZ (3PST) Intermatic T1471BCR
 - 4. Or approved equal

2.07 TIME CLOCK (24 HOUR)

A. General

1. A 40 ampere electro mechanical 24 hour time switch.
2. Turn "ON" initiated by photo cell; can be set 20 or 40 minutes before or after normal sunset to adapt to local area.
3. Turn "OFF" at pre-set time adjustable in half hour increments.
4. Day-omitting feature: switch shall operate every day unless set to omit selected days.
5. Battery backup in the event of a power outage.

B. Time switch contacts shall be capable of switching 10 amperes per pole continuously at 120 volts and shall be four pole.

C. "ON" operation shall occur automatically as initiated by the photocell. "OFF" operation shall be adjustable in one half hour increments.

D. Enclosure shall be NEMA 1 surface type. Enclosure shall be finished in baked epoxy enamel with combination 1/2" and 3/4" knockouts on bottom both sides, top and back. Provision shall be made for positive padlocking and/or sealing.

E. Terminals shall be of the pressure type capable of receiving #8 AWG wire.

F. Manufacturers: Tork #7100; Intermatic T171

2.10 CONTACTORS

A. Use: in separate NEMA 1 enclosures to operate number of circuits simultaneously.

B. Type

1. Single coil, magnetically operated, mechanically locked type without hooks on latches.
2. Mounting: on dampening device or in insulated cabinet.
3. Contacts: silver with auxiliary arcing contacts.
4. Lockout relays: to prevent simultaneous operation from two remote locations.
5. Solid state control module for 2-wire control.
6. Manufacturers: ASCO, Bulletin #918

C. Remote control: three position momentary contact switch similar to Hubbell #1557.

2.11 PILOT LIGHT (OTHER THAN FOR MOTORS CIRCUITS)

A. Red rectangular jewel with integral 125 volt neon lamp. Suitable for mounting in single gang box.

B. Manufacturers: General Electric #GE04218-0; or approved equal.

2.12 WALL DIMMER CONTROLS

- A. All devices shall be U.L. listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage transformer, electronic low voltage transformer). Manufacturer shall provide file card upon request. Universal dimmers shall not be acceptable.
- B. All dimmers shall incorporate an airgap switch which shall be accessibility without removing the faceplate. The airgap switch shall be capable of meeting all applicable requirements of U.L. 20 for airgap switches in incandescent dimmers.
- C. All dimmers shall provide power failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default levels is not acceptable.
- D. Dimmers shall meet the ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
- E. Dimmers shall meet the U.L. 20 limited short circuit test requirement for snap switches.
- F. Dimmer control shall be linear slide type. Dimmer shall provide a smooth and continuous Square Law Dimming curve.
- G. Dimmer shall include voltage compensation circuitry that adjusts the firing angle of the dimmer in such a manner as to compensate light output for variations in the AC line voltage. Dimmers in which the firing angle is merely held constant with varying AC line voltage shall not be acceptable.
- H. Dimmer control slider shall be captive to the dimmer wall faceplate.
- I. All switches grouped with dimmers shall also be slide type to match.
- J. Manufacturer: Lutron "Nova T Star" dimmers and switches or approved equal.

2.13 (DUAL TECHNOLOGY) OCCUPANCY SENSORS

- A. The device listed herein shall be an occupancy / vacancy sensor, (ceiling type switch or wall mounted switch with manual override), capable of detecting infrared emissions from human presence and ultrasonic motion detection, and responding by switching incandescent, low-voltage and fluorescent lighting loads on. If this unit does not detect infrared emissions or movement after a preset period of time, it will respond by switching its assigned load off. The unit shall switch at the zero crossing point of the AC power curve to ensure maximum relay contact life, and compatibility with electronic ballasts.
- B. Unit shall provide automatic adjustable walk-through feature to prevent lights from remaining on for extended periods after momentary occupancy in the area being monitored.
- C. The Ceiling Switch Occupancy Sensor shall feature self-adjusting delayed-OFF time and ambient light override capabilities.

- D. Unit shall also provide 360° field of view, of 180° field of view for wall mounted switches, and shall have sensitivity adjustments.
- E. Coverage area shall be approximately 2000 sq.ft.
- F. Manufacturer: Leviton #OSC20-MOW or #OSSMT Series or approved equal

2.14

(PASSIVE INFRARED) OCCUPANCY SENSORS

- A. The device listed herein shall be a ceiling type switch occupancy sensor, capable of detecting infrared emissions from human presence and responding by switching incandescent, low-voltage and fluorescent lighting loads on. If this unit does not detect infrared emissions or movement after a preset period of time, it will respond by switching its assigned load off. The unit shall switch at the zero crossing point of the AC power curve to ensure maximum relay contact life, and compatibility with electronic ballasts.
- B. Unit shall provide automatic adjustable walk-through feature to prevent lights from remaining on for extended periods after momentary occupancy in the area being monitored.
- C. Unit shall also provide 180° field of view and shall have sensitivity adjustments.
- D. Coverage area shall be approximately 2000 sq.ft.
- E. Locations of occupancy sensors shown on drawings are representative and the quantity of sensors may not be adequate for specific manufacturers. In areas indicated for automatic control, coverage data issued by manufacturer shall be used to determine locations for proper coverage and sensors required shall be provided by the contractor.
- F. Manufacturer: Leviton #ODS15-IDW or approved equal

PART 3: EXECUTION

3.01

SWITCHES AND RECEPTACLES

- A. Install switches and receptacles of adequate rating and capacity for loads served.
- B. Install single (multi-gang) wall plates for outlet boxes with more than one device.
- C. Receptacle Orientation: Vertically mounted receptacles shall be installed with ground pin slot up; horizontally with neutral blade slot up.

3.02

120 VOLT RECEPTACLE CIRCUITS

- A. Perform operational testing.
- B. Test receptacles with Woodhead #1750 or Hubbell #5200 Tester for proper connection of ground wire, correct polarity and faults in wire.

3.03

LABELS

- A. Inside the coverplate of each receptacle shall be labeled identifying panelboard and branch circuit device serving the receptacle using clear tape. Label with 3/16" black letters.
- B. Special purpose receptacles such as x-ray or other such equipment shall be labeled with engraved or embossed label identifying load served as well as the circuit and panelboard identification described above.

END OF SECTION

SECTION 26 27 27 – FLOOR BOXES

PART 1: **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Electrical General Provisions: Section 25 05 01
- B. Raceways and Boxes for Electrical Systems: Section 26 05 33
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19

1.02 SCOPE

The floor box provides the interface between power and communication cabling in a concrete floor, where both power and communication device outlets are required. The box provides recessed device outlets that will not obstruct the floor area.

1.03 CLASSIFICATION AND USE

The floor box is approved for use on above-grade concrete floors, and can be used on-grade with a vapor barrier where permitted by local code. The floor box shall have been examined and tested by Underwriters Laboratories Inc. to their Standard UL514A and bear the listing mark. It shall also bear the Canadian UL mark. The floor box shall conform to the standards set in the National Electrical Code. This floor box shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

PART 2: **PRODUCTS**

2.01 MATERIALS

- A. Floor Box Construction - boxes shall consist of a concrete-tight stamped steel construction with 14 gauge sides and bottom and 10 gauge steel top. The floor box shall be painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on grade and above-grade floors.
 - 1. Dimensions: the box exterior dimensions are to be 14-3/4" (356mm) long x 12-5/8" (321mm) wide. The height may be either 4-1/8" (105mm) or 6-1/8" (156mm).
 - 2. Capacity: the wiring volume for the floor box shall comply with the following table:

No. of Compartments	No. of Gangs/ Volume of Compartment 1	No. of Gangs/ Volume of Compartment 2	No. of Gangs/ Volume of Compartment 3	No. of Gangs/ Volume of Compartment 4
4	3 gangs 84 CU.in (1377ml)	1 gang 35 CU.IN (574 ml)	1 gang 35 CU.IN (574 ml)	6 gangs 156 CU.IN (2589 ml)

3. Knockouts: The floor box shall provide the following number of conduit knockouts: four combination 1" and 1-1/4" concentric trade size, four combination 3/4" and 1" concentric trade size, and ten combination 1-1/4" and 2" concentric trade size.
4. Adjustment: external pre-pour adjustment shall be provided by at least 2" leveling screws.

B. Cover:

1. Cover shall be cast aluminum. Lid to be offered with solid, flush surface for tile, wood or terrazzo and an insert option for carpet inlay.
2. Egress to be provided by two 15/16" x 6-3/8" (23.8mm x 161.9mm) access doors. Access door is to fold under lid during cable exit for unobtrusive appearance and mechanical protection.

2.02 COMMUNICATION DEVICES AND ACCESSORIES

The floor box manufacturer will provide a complete line of communication outlets and modular inserts for UTP, STP (150 OHM), Fiber Optic, Coaxial, audio and video devices with faceplates and bezels to facilitate mounting. The box shall provide a series of device mounting plates that will accommodate Ortronics workstation connectivity outlets and modular inserts, the Pass and Seymour Network Wiring System, and other open system devices. Box to accept industry standard size one, two, and three-gang device plates and sectional device plates.

2.03 MANUFACTURERS

Wiremold RFB11 or approved equal.

PART 3: **EXECUTION**

3.01 INSTALLATION

The floor box shall contain four leveling legs to provide full pre-concrete pour adjustment. Additionally, the box shall ship with a disposable cover to prevent the entry of debris during the construction phase. Alternate disposable covers to provide terrazzo pour stops is to be available from the manufacturer.

END OF SECTION

SECTION 26 28 00 – LOW VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Raceways and Boxes: Section 26 05 33
- D. Performance Testing: Section 26 08 01
- E. Panelboards: Section 26 24 16
- F. Low Voltage Controllers: Section 26 29 00

1.02 WORK INCLUDED

Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein.

- A. Circuit Breakers
- B. Fuses (Low Voltage)

1.03 SUBMITTALS

Submit shop drawings for distribution equipment in accordance with Specifications Section 26 05 01, General Provisions.

PART 2: PRODUCTS

2.01 CIRCUIT BREAKERS

- A. Contractor shall provide the following unless otherwise specified or shown on the drawings. See "Panel Schedules" for minimum panelboard I.C. ratings. All breakers in these panels shall meet the minimum panelboard ratings. Series integrated equipment rating is not acceptable.

<u>Type of Service</u>		<u>Frame Size</u> <u>(Amperes)</u>	<u>I.C. Rating</u> <u>(Amperes)</u>
1.	120/208 volt, single phase lighting & power	15-60	10,000
2.	120/208 volt, three phase power	15-60	10,000
3.	120/208 volt, three phase power	70-200	22,000
4.	120/208 volt, three phase power	225-400	42,000

<u>Type of Service</u> (Cont.)		<u>Frame Size</u> (Amperes)	<u>I.C. Rating</u> (Amperes)
5.	120/208 volt, three phase power	450-1200	50,000
6.	277/480 volt, single phase lighting & power	15-60	14,000
7.	277/480 volt, three phase power	70-200	42,000
8.	277/480 volt, three phase power	225-400	42,000
9.	277/480 volt, three phase power	450-1600	42,000

- B. Provide circuit breakers where indicated of proper sizes for loads served.
- C. Do not install two poles in single module.
- D. Install multiple pole breakers with single trip mechanism. Do not install external mechanical ties between single pole breakers.
- E. Manufacturers: General Electric; Siemens; Square "D"; Cutler-Hammer

2.02 FUSES

- A. 601 amps and above: UL Class L current limiting type, 200,000 amp interrupting capacity, 4 second time delay at 500% rating. Buss Hi-Cap KRP-C; Ferraz-Shawmut Amptrap A4BY, Reliance LCL or Littelfuse KLP-C.
- B. 600 AMPS and Below
 - 1. Protecting branch circuit panelboards and miscellaneous non-inductive loads: fuses to be current limiting type, single element with no time delay, 200,000 amp interrupting capacity. UL Class RK1. Buss Limitron KTN, KTS; Ferraz-Shawmut Amptrap A2K, A6K, Reliance NCL-R, SCL-R or Littelfuse KLN-R, KLS-R.
 - 2. Motor circuits and transformers: dual element type 200,000 amp interrupting capacity. UL Class RK5. Buss Fusetron FRN-R, FRS-R, Ferraz-Shawmut Tri-Onic TR, TRS; Reliance ECN-R, ECS-R; or Littelfuse FLN-R, FLS-R.

PART 3: EXECUTION

3.01 FUSES

- A. Provide the Owner with 10% additional spare fuses (or a minimum of three which ever is greater) for each size fuse used in the installation.
- B. Fuses to be stored in special cabinet located adjacent to each substation, MCC or fusible panelboard containing fuses.
- C. Submit shop drawings of cabinet for approval.

END OF SECTION

SECTION 26 29 00 – LOW VOLTAGE CONTROLLERS

PART 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Raceways and Boxes: Section 26 05 33
- D. Performance Testing: Section 26 08 01
- E. Panelboards: Section 26 24 16

1.02 WORK INCLUDED

Furnish and install material, labor and accessories required for the following pieces of equipment as shown on the drawings and specified herein.

- A. Motor Starters
- B. Safety Switches

1.03 SUBMITTALS

Submit shop drawings for distribution equipment in accordance with Specifications Section 26 05 01, General Provisions.

PART 2 **PRODUCTS**

2.01 MOTOR STARTERS

- A. Type
 - 1. Full voltage across-the-line starters with motor running protection in accordance with Motorized Equipment Schedule shown on the drawings and as indicated below.
 - 2. Starters to be equipped with auxiliary control devices as indicated on Motorized Equipment Schedule.
 - 3. Starters operated at a phase-to-phase voltage of 200 volts or more shall be equipped with individual transformers to provide 120-volt supply for control devices such as pushbutton, relays, float switches, etc.
- B. Use
 - 1. Manual: single phase up to 1/2 HP; with pilot light similar to Allen Bradley Bulletin 600 series.
 - 2. Manual: single phase 3/4 HP and greater; similar to Allen Bradley Bulletin 609 series.
 - 3. Magnetic: single or three phase; similar to Allen Bradley 509 series.
 - 4. Combination magnetic starter with fused switch (circuit breaker switch). Similar to Allen Bradley Bulletin 512 series (513 series).
 - a. All combination magnetic starters shall have hand off automatic

- switches with pilot light unless otherwise noted.
 - b. All combination magnetic starters to be equipped with control circuit transformers unless otherwise noted.
- C. Pushbutton Stations: heavy duty type in NEMA 1 enclosure; similar to Allen Bradley Bulletin 800H series.
- D. Control Circuits
 - 1. Control circuit voltage shall be not to exceed 120 volts and shall be obtained through the use of control circuit transformers.
 - 2. Transformers shall be of sufficient size to service control device connected thereto.
 - 3. Control circuit shall be made in the following manner:
 - a. One side of secondary of transformer shall be grounded.
 - b. One side of all operating coils of control devices shall be connected to grounded side of control circuit.
 - c. All contacts of relays, limit switches, etc., shall be connected in series on line side of the control circuits.
 - 4. A minimum of two (2) spare interlocks shall be furnished per starter or contactor. These interlocks shall be field reversible from normally open to normally closed.
 - 5. All terminal points, including interlock contacts, shall be brought out to terminal blocks.
- E. Manufacturers: Allen Bradley; Square D; General Electric; Siemens; Cutler Hammer

2.02

SAFETY SWITCHES

- A. UL approved, heavy duty, 2 and 3 pole, quick-make, quick-break fused or non-fusible type, as indicated on the drawings. Fuse clips shall be suitable for the fuses specified under this section.
- B. Totally enclosed with external operating handle. Enclosure to be NEMA type as indicated on the drawings.
- C. Manufacturers: General Electric; Square D; Siemens; Cutler Hammer

PART 3

EXECUTION

3.01

MOTOR STARTER INSTALLATION

- A. Motor starters furnished under other sections are to be mounted by the Electrical Contractor.
- B. Mount on walls or on approved type floor stands.
- C. Floor stands to be constructed of mild steel angle iron or channel such as Unistrut or Kindorf. Bolts shall not project more than necessary for structural purposes.
- D. Starter interlocked with other starters or control to be provided with labels on inside of cover stating nature of the interlock system. (Example: interlocked with 120V circuit from exhaust fan.)

- E. Rotation
 - 1. Connect motors for correct rotation before they are connected to driven load.
 - 2. Repair or replace (at the Owner's option) motors and equipment damaged because of incorrect motor rotation.
- F. Conduit: use flexible liquid tight conduit for all connections.
- G. Install overload relay heater elements and ascertain that size of heater elements corresponds to motor full load current and that motors will start and operate immediately.
- H. Mount pushbutton 4'-0" above finished floor.
- I. Mount individual starters 6'-0" from finished floor to top of starter.
- J. Control Circuits
 - 1. Perform continuity tests.
 - 2. Check control and interlocking wiring for the proper operation.

3.02 MOTOR TESTS AND DATA

- A. Check all motors for correct rotation. The Electrical Contractor shall be available during operation of the balancing and adjusting mechanical systems and shall make such changes in wiring, heater sizes and other adjustments as are required to permit proper balancing of the systems.
- B. Refer to additional testing requirements in Section 26 08 01 Performance Testing and Electrical Systems.

3.03 SAFETY SWITCH INSTALLATION

- A. Mount safety switch on walls or on approved type floor stands with top +6'-0" A.F.F.
- B. Floor stands to be constructed of mild steel angle iron or channel type such as Unistrut or Kindorf. Bolts shall not project more than necessary for structural purposes.
- C. Install HP rated, non-fused, motor disconnect switch at each motor location.

END OF SECTION

SECTION 26 43 13 – SURGE PROTECTION DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- D. Switchboards: Section 26 24 14
- E. Panelboards: Section 26 24 16
- F. Low Voltage Controllers: Section 26 29 00
- G. Low Voltage Circuit Protective Devices: Section 26 28 00

1.02 SUBMITTALS

Submit shop drawings or data sheet on SPD equipment used in accordance with Specification Section 26 05 01, General Provisions.

1.03 SUMMARY

These specifications describe the electrical and mechanical requirements for a high energy surge protection devices (abbreviated as SPD in this specification and on all drawings). The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Types 1, 2, 3, or 4 environments, as indicated on drawings. The system shall meet these requirements as tested by ANSI/IEEE C62.11, C62.45. The system shall be connected in parallel with the protected system; no series connected elements shall be used which limit load current or KVA capability.

1.04 STANDARDS

- A. The specified system shall be designed, manufactured, tested and installed in compliance with:
 - 1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
 - 2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
 - 3. National Electrical Manufacturer Association (NEMA Publication LS-1)
 - 4. National Fire Protection Association (NFPA 20, 70, 75 and 78)
 - 5. Underwriters Laboratories (UL 1283 and UL 1449, 3rd Edition)
 - 6. National Electrical Code (NEC)
- B. The system shall be UL listed as passing the applicable location category current waveforms specified in UL1449 (3rd Edition). The listings shall be displayed on the unit with a permanently attached factory label. The ratings of the system must be supported by 'published' test data from an independent laboratory which verifies the repetitive surge current impulse ratings. Also, to support the UL 1449 testing, a report needs to indicate the VPR rating and actual fault current withstand rating.

1.05 SYSTEM DESCRIPTION

- A. System Operating Voltage and applicable modes: The nominal system operating voltage shall be 277/480V, three (3) phase WYE, 4 wire plus ground, L-N, L-G and N-G.
- B. The SPD maximum continuous operating voltage shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage (swell) conditions.
- C. The operating frequency range of the system shall be at least 57 to 63 Hertz.
- D. Provide capacitors as required to not provide additional noise to system in accordance with UL 1283.
- E. Overcurrent Protection (Fusing): All protection modes of type shall be internally fused with the fuses In capability to allow the suppressor's maximum rated transient current to pass through the SPD without fuse operation. If the rated In characteristics of the fusing is exceeded, the fusing shall be capable of opening and clearing both high and low impedance fault conditions. This overcurrent protection circuit shall be monitored and provide indication of suppression failure/operability.
- F. The SPD shall provide protection for modes as outlined in "system operating voltage and applicable modes" above. Note: L= Line, N= Neutral, G= Ground.
- G. The SPD multiple surge current minimum rating for any one individual mode (L-L, L-N, L-G or N-G) based on the standard 8 x 20 microsecond impulse shall be no less than:
 - Location Type 3 Panelboards - 35,000 Amperes
 - Location Type 2 Main Distribution - 55,000 Amperes
 - Location Type 1 Service Entrance - 120,000 Amperes
- H. The system performance ratings shall be based on the appropriate UL, 1449 3rd Edition listing ratings for the applicable IEEE C62.41 impulse waveforms.

1.06 DEFINITION

The category of the surge protection device (SPD) shall be determined by it's location according to the following descriptions:

- Type 3 - This shall be any branch circuit panelboard located more than 30 circuit feet from the service equipment.
- Type 2 - Main distribution panel
- Type 1 - This shall be any device installed on load or line side of the main service over current protection (OCP).

1.07 PROJECT SCOPE

This project contains the following equipment categories.

- A. Type 3
- B. Type 2
- C. Type 1

PART 2: PRODUCTS

2.01 SURGE SUPPRESSION COMPONENTS

- A. The system shall be constructed using multiple surge current diversion modules utilizing matched metal oxide varistors (MOV). Each module shall be capable of withstanding over 1,000 pulses of the applicable IEEE62.41 Category surge current without failure or degradation of performance when tested per C62.11, C62.45, suggested wait times. The modules shall be designed and constructed in a manner which ensures MOV surge current sharing.
- B. Terminals shall be provided for all of the necessary power and ground connections. The terminals shall accommodate wire sizes of up to #6 AWG for Type 3, #2 AWG for Type 2 and #1/0 AWG for Type 1.
- C. All surge current diversion module intra-unit connections shall be by way of low impedance connections. All module mounting hardware and power wiring shall be captive or remain in place when a module is removed or replaced. The system shall be designed for simple change out of any or all SPD components modules by a qualified electrician.
- D. The specified system shall be provided in a heavy duty NEMA 1 enclosure. The cover of the enclosure shall be hinged and require a tool for access to internal components. Indication of surge current module status shall be visible without opening the door.

2.02 ACCESSORIES

- A. Unit Status Indicators: Status indicators with printed labels shall be provided on the hinged front cover to continually indicate each modules status. Indicator shall reliably indicate that one or more surge current diversion modules or fuses have failed and that service is needed to restore full operation. All protection modules and modes (including N-G) shall be monitored.

2.03 MANUFACTURERS

- A. Current Technology
- B. L.E.A. International
- C. Liebert
- D. Square D
- E. Eaton

PART 3: EXECUTION

3.01 **SURGE PROTECTION DEVICE INSTALLATION**

- A. Mount surge protection device adjacent to panelboards, switchboard and switchgear as indicated on the drawings.
- B. Mount device to maintain minimum wire length between device and protected source. MAXIMUM LENGTH:
 - 1. Switchboards: 48" with minimal wire bends.
 - 2. Panelboards: 12" with minimal wire bends.
- C. Run wiring in non-metallic conduit as straight as possible. If a conduit bend is required use long radius bends.
- D. Install overcurrent protection and disconnecting means for surge devices in accordance with National, State and Local Codes.

END OF SECTION

SECTION 26 51 00 – INTERIOR LIGHTING

PART 1 **GENERAL**

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary, apply to this Section.
- B. See LUMINAIRE SCHEDULE in electrical drawing set for all luminaires specified by NEO Engineers Lighting.
- C. Luminaires/Ceiling Systems - See related sections for ceiling systems. Contractor to coordinate luminaire trims, accessories and components to insure lighting and ceiling systems compatibility. See section 1.4 SUBMITTALS for Contractor submittal information/confirmation.

1.02 SUMMARY:

- A. Scope: The extent of interior lighting required is indicated on the drawings and schedules and by the requirements of this Section and all related Electrical Specification Sections.
- B. Furnish and install material, labor, and accessories required for the following pieces of equipment as shown on the drawings and specified herein.
- C. Types of luminaires specified in this Section are for indoor use and include the following:
 - 1. Fluorescent (FL)
 - 2. LED
 - 3. Exit Signs
 - 4. Emergency Lighting Units
- D. Related Sections: Refer to other Electrical Specification sections for the following:
 - 1. Section 26 51 00 - Luminaire Schedule

1.03 SUBSTITUTIONS

- A. No substitutions will be accepted after bids are received: The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous performance requirements of this project.
- B. One Manufacturer or "Pre-Bid Approved Equal": When only one manufacturer is listed within the description of the luminaire, the engineering, performance or aesthetics *MAY NOT* allow substitution of other manufacturers. "NEO Lighting Pre-Bid Approved Equal" permits pre-bid submittal of a product for NEO Lighting consideration under submittal guidelines established by this specification section.
- C. Three Manufacturers: When three manufacturers are listed on the Luminaire Schedule, the design, engineering, or architectural aesthetics will allow the CONTRACTOR to choose one of the three manufacturers listed. The first manufacturer listed by name and catalog number is the basis of design. The second and third manufacturer's name will be noted along with the wording "EQUAL PRODUCT" instead of a catalog number. The second and third listed

manufacturer's "EQUAL PRODUCT" shall be provided which meets or exceeds the manufacturer's product noted with catalog number in materials, finish, components and accessories. NEO Lighting will have final opinion of "EQUAL PRODUCT" interpretation. Contractor/Distributor/Representative must formally submit questions in writing. All submittals must be in NEO Lighting possession not later than ten (10) business before the bid opening. NEO Lighting will issue a formal written response thru official channels.

- D. Luminaire Substitutions/Substitution Packages: CONTRACTOR may elect to submit to NEO Lighting a luminaire substitution package for review. All submittals must be in NEO possession not later than ten (10) business days before the bid opening. All luminaire substitutions must meet the following requirements or will be rejected outright by NEO Lighting.
- E. Substitution submittals requirements: A luminaire substitution (substitution package) shall consist of the following information or will be rejected outright by NEO Lighting:
 - 1. Original luminaire cut sheet noting exact options / features of the proposed product in detail/dimensional accuracy.
 - 2. Color image of luminaire, in the configuration of the proposed product.
 - 3. Dimensioned drawing of luminaire to an identified scale per sheet print size.
 - 4. Electric data of the proposed luminaire with specified lamp, ballast, transformer, driver or power supply.
 - 5. REVIT Files – Provide face-based REVIT content files for each luminaire type being substituted.
 - 6. IES format photometric files for the proposed luminaire with specified lamp.
 - 7. Photometric reports must list the actual candela values for the luminaires' distribution in at least three planes. Copies of candela curves, footcandle and lumen tables and iso-footcandle contours must also include IES format electronic photometric files identified by NEO Luminaire type.
 - 8. Calculations - Substitutions for luminaire types impacting "calculation / light level sensitive" project rooms / areas must be submitted with a complete point by point calculation grid of the area utilizing the substituted luminaire and adjacent luminaires contributing to the light levels. The point by point submittal must include a statistical chart showing all fixed and variable calculation factors including, but not limited to: initial / maintained lamp lumens, all LLFs (Light Loss Factors), lamp/luminaire mounting heights, calculation plane height(s), surface reflectance's, complete Luminaire model numbers and calculation point spacing. Calculations will be rejected outright by NEO without this information. NEO reserves the right to obtain an electronic copy of the calculation files and the substitute luminaire IES files. NEO may run a comparison calculation model using AGI.
- F. All substitution submittals shall be provided to NEO Lighting in two formats:
 - 1. Hard/paper copy: (1) hard / paper copies shall be provided to NEO Lighting in a green 3-ring binder. DVD/CD of all content in binder shall be included in each binder.
 - 2. Electronically posted files shall be delivered thru Owner / Architect / Contractor established communication channels. No files shall be directly delivered to NEO Lighting by vendors or their agents.
- G. Lighting Designer Fee Compensation

1. CONTRACTOR will be responsible for all costs (architecture time, NEO Lighting time, engineering time, manufacturer's costs, distributor costs, etc.) incurred to replace installed lighting equipment not approved by NEO Lighting.
2. CONTRACTOR shall pay professional fees at current standard hourly rates and reimburse expenses directly to all design professionals for time spent reviewing substitutions proposed by the Contractor after the bid has been awarded. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
3. Additional fees will be required for all submittals / substitution reviews exceeding (3) shop drawing submittals per luminaire.

1.04

SUBMITTALS

- A. General: Furnish submittals in accordance with the requirements of the related section.
- B. Coordination: All luminaire drawings shall be coordinated with the drawings and details of the Architectural, Structural, Electrical, Mechanical, and other related trades to assure a perfect and efficient installation.
- C. No Variations: No variations from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance by the architect. All variations must be clearly marked on the drawings submitted for approval.
- D. Shop Drawings: Submit legible, dimensioned drawings of specified lighting assemblies including:
 1. Luminaire Shop Drawings - Luminaire shop drawings shall clearly indicate:
 - a. Specified luminaire accessories, finishes, components on each sheet. If only the catalog number is provided without graphically identifying the exact luminaire accessories, finishes, components on each sheet, the luminaire type will be REJECTED AS NOTED.
 - b. Modified or custom luminaires require a factory produced shop drawing. Standard luminaire cut sheet annotated/noted as "modified" will not be permitted (even for lamping modification) the luminaire type will be REJECTED AS NOTED.
 - c. No hand-written notes are permitted on lighting shop drawing submittals or the luminaire type will be REJECTED AS NOTED.
 - d. Catalog cuts lacking sufficient detail to indicate compliance with contract documents will be REJECTED AS NOTED.
 - e. Luminaires / ceiling systems - See other specification sections for ceiling systems.
 - 1) Contractor responsible to coordinate luminaire and ceiling systems compatibility of hardware, trims and materials.
 - 2) Ceiling / Luminaire Trim Contractor coordination must be noted as verified on each shop drawing by Contractor for luminaire in final approved/purchased ceiling type, which may be a ceiling system different than originally specified.
 - 3) One luminaire type may be installed in multiple ceiling types requiring the following submittals.

- a) A separate cut sheet must be provided for each luminaire and unique ceiling system noting coordination.
 - b) A spreadsheet/matrix of luminaire types and ceiling types coordinating above details.
- 4) Contractor to provide Lighting Manufacturers with both CAD and face based REVIT files of the ceiling systems for luminaire compatibility/integration/coordination.
2. Lamp shop drawings - "Lamp Schedule" matrix shall be submitted noting luminaire types and the lamp type designation / lamp manufacturer provided in each luminaire type. One (typical) lamp cut sheet for each unique lamp type shall be submitted for review / approval.
3. Ballast shop drawings – "Ballast Schedule" matrix shall be submitted noting luminaire types and the ballast type designation / ballast manufacturer provided in each luminaire type. One (typical) ballast cut sheet for each unique lamp type shall be submitted for review / approval.
4. Booklet format - Shop drawings shall be submitted in booklet form organized with a separate sheet for each luminaire type, ballast type, lamp type, and Contractor's luminaires/Ceiling Systems compatibility confirmation assembled in order of luminaire "type" designation.
5. Submittal format - Submittals shall be provided to NEO in two formats:
 - a) Hard/paper copy (3 ring binders). (2) hard/paper copies shall be provided to NEO Lighting. One set to NEO and one set to a NEO designated individual/company. DVD/CD of all content in binder shall be included in each binder.
 - b) Electronically posted files shall be delivered thru Owner/Architect/Contractor established communication channels. No files shall be directly delivered to the NEO or EE Team by vendors or their agents.
- E. Ballast Location Submittal Drawings: Provide shop drawings clearly noting the location of multiple lamp ballasts in all continuous runs of fluorescent luminaires for NEO Representative Review. The fewest available multiple lamp ballasts shall be used in each fluorescent luminaire continuous run. These submittal drawings are required at time of Luminaire Shop Drawing submittal review to NEO.
- F. Record Shop Drawings Required: Record luminaire, ballast and lamp shop drawings shall be delivered to the NEO at time of Substantial Completion. All "Approved as Noted" comments shall be corrected / picked-up in this record set. All shop drawing review comments shall be included in this set. Record luminaire shop drawings shall be provided in a three-ring binder and electronically on DVD/CD(s).
- G. Luminaire ordering schedules and shop drawing schedules: All lighting equipment shall be ordered in a timely manner. The Contractor shall provide a spreadsheet to NEO Lighting with the following detailed information organized by luminaire type:
 1. Originally quoted delivery dates (6-8 weeks, etc) from time of Bidding.
 2. Shop drawings delivery dates to NEO Lighting.
 3. Dates when equipment orders are placed/finalized per approved shop

- drawings.
- 4. Final product delivery schedules.
- 5. Long lead items - At time of original quote/bid, Contractor is required to identify any long lead lighting items and identify in the master project construction schedule for trade coordination.
- H. Battery and charger data shall be submitted for emergency lighting units.
- I. Electrical ratings and photometric data with certified results of independent laboratory tests for luminaires and specified lamps.
- J. Field test reports indicating, and interpreting test results specified in Part 3 of this section.
- K. Maintenance manual: Refer to Section 26 05 01 for general requirements. At the completion of the project, the luminaire manufacturer shall furnish to the owner a recommended lighting maintenance manual. Each maintenance manual shall include:
 - 1. Tools Required.
 - 2. Types of cleaners to be used.
 - 3. Replacement parts identification lists.
 - 4. Final as built shop drawings.
- L. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.
- M. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of NEO. All variations must be clearly marked as such on the drawings submitted for approval.

1.05

QUALITY ASSURANCE:

- A. Standards: Materials, equipment, and appurtenances as well as workmanship provided under this section shall conform to the highest commercial standard as specified and as indicated on drawings.
- B. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- C. Listing and Labeling: Provide Luminaires, emergency lighting units, and accessory components specified in this section that are listed and labeled for their indicated use and installation conditions on Project.
 - 1. Special Listing and Labeling: Provide Luminaires for use in damp and wet locations that are specifically listed and labeled for such use.
 - 2. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.06

PROJECT CONDITIONS:

- A. The Contractor is responsible for confirming compatibility and interface of other materials with the luminaire and ceiling system and shall provide proper luminaire

extender rings, plaster frames, flange kits, etc. for ceiling system in which it will be installed. Report discrepancies to the Architect and defer ordering until clarified.

- B. Coordinate with the ceiling contractor in locating recessed and surface mounted luminaires.
- C. Coordinate with divisions 21, 22, and 23 to avoid conflicts between luminaires, supports, fittings, and mechanical equipment.
- D. Coordinate layout and installation of luminaires and suspension systems with other construction that penetrates the ceiling or is supported by them including HVAC equipment, fire suppression systems, and partition assemblies.

1.07

WARRANTY:

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty for Batteries: Submit a written warranty executed by the manufacturer agreeing to replace rechargeable system batteries that fail in materials or workmanship within the specified warranty period. The Special Warranty Period on rechargeable system batteries shall be not less than 10 years after date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last 9 years.

PART 2

PRODUCTS

2.01

MANUFACTURERS:

- A. Products: Subject to compliance with requirements, provide one of the products specified in the Luminaire Schedule on the drawings or follow the substitution requirements for NEO Lighting consideration.

2.02

LUMINAIRES AND LUMINAIRE COMPONENTS, GENERAL:

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Face plates or frames of recessed luminaires that serve as ceiling trim and swing to allow access to the interior of the luminaire shall be gasketed.
- D. Reflecting Surfaces: Minimum reflectance as follows:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or

water white, annealed crystal glass:

- a. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - b. Lens Thickness: 0.125-inch (3 mm) minimum; except where greater thickness is indicated.
- E. Fluorescent Luminaires: Conform to UL 1598.
- F. Provide lampholders for the proper performance of lamps in luminaire, UL listed, of a type designed and acceptable for the purpose and bearing the manufacturers' name or trademark, type, number, and rating on each item.
- G. Housings shall be constructed so all electrical components are easily accessible and replaceable without removing them from their mountings.
- H. Light Leaks between ceiling trims of recessed lighting equipment and the ceilings will not be tolerated. If Luminaire is used in partials transparent ceiling, light leaks above the ceiling line will not be tolerated.

2.03

SUPPORTS:

- A. Luminaire Support Components: Comply with Electrical Specification section "Basic Electrical Materials and Methods." All Luminaire Support Components shall be individually supported from the structure above and shall not be supported directly from a suspended ceiling system. Contractor shall coordinate exact mounting hardware necessary for installation based on the specified ceiling systems and shall verify on shop drawing submittals.
- B. Suspend or support independently of the ceiling construction all recessed luminaires which are not the lay-in grid type and all surface type luminaires in or on the ceiling from the structural members above.

2.04

FLUORESCENT BALLASTS (T8):

- A. Acceptable Manufacturers:
- 1. Lutron
 - 2. Advance
 - 3. GE
- B. Performance Requirements:
- 1. Ballast shall be Program Start.
 - 2. Ballast shall contain auto restart circuitry in order to restart lamps without restarting power.
 - 3. Ballast shall operate from 50/60Hz input source of 120V thru 277V with sustained variations of +/- 10%.
 - 4. Ballast shall be high frequency type and operate at a frequency above 42kHz to avoid interference with infrared devices and eliminate visible flicker.
 - 5. Minimum Power Factor: 98 percent or greater for primary lamp.
 - 6. Ballast Factor: Minimum 1.0 for primary lamp.
 - 7. Lamp Current Crest Factor: 1.7 or less.
 - 8. Total Harmonic Distortion (THD) of Ballast Current: Less than 10 percent.
 - 9. Ballast shall have Class A sound rating.

10. Ballast shall have a minimum starting temperature of 0°F.
11. Ballast shall provide Lamp EOL (end of life) Protection circuit.
12. Ballast shall tolerate sustained open circuit and short circuit output conditions.
13. Parallel lamp circuits: Multiple lamp ballasts shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

C. Regulatory Requirements:

1. Ballast shall be UL listed, Class P certified.
2. Comply with ANSI C62.41 Category A for transient protection.
3. Comply with ANSI C82.11
4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non-consumer Class A for EMI/RFI (conducted and radiated).
5. Comply with UL Type CC rating.
6. Comply with NEMA 410 for in-rush current limits.

2.05 FLUORESCENT DIMMING BALLASTS:

A. Acceptable Manufacturers:

1. Lutron
2. Advance
3. Osram Sylvania

B. Performance Requirements:

1. Ballast shall control lamp light output from lamps and 100% to 10% for T5/HO lamps unless otherwise specified.
2. Ballast shall be Programmed Rapid Start.
3. Ballast shall contain auto restart circuitry in order to restart lamps without restarting power.
4. Ballast shall operate from 50/60Hz input source of 120V thru 277V with sustained variations of +/- 10%.
5. Ballast shall be high frequency type and operate at a frequency above 42kHz to avoid interference with infrared devices and eliminate visible flicker.
6. Minimum Power Factor: Greater than 98 percent at full light output and greater than 90% throughout the dimming range.
7. Ballast Factor: Minimum 1.0 at maximum light output and .05 at minimum light output for primary lamp.
8. Lamp Current Crest Factor: 1.7 or less.
9. Total Harmonic Distortion (THD) of Ballast Current: Less than 10 percent.
10. Ballast shall have Class A sound rating.
11. Ballast shall have a minimum starting temperature of 50°F.
12. Ballast shall provide Lamp EOL (end of life) Protection circuit.
13. Ballast shall tolerate sustained open circuit and short circuit output conditions.
14. Ballast shall ignite the lamps at any light output setting without first going to another output setting.

C. Regulatory Requirements:

1. Ballast shall be UL listed, Class P certified.
2. Comply with ANSI C62.41 Category A for transient protection.

3. Comply with ANSI C82.11 max allowable THD requirements
4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non-consumer Class A for EMI/RFI (conducted and radiated).
5. Comply with UL Type CC rating.
6. Comply with NEMA 410 for in-rush current limits.

2.06

LED DRIVERS

- A. Complete System: The contractor shall furnish the completed LED-based lighting system. A 'Complete System' shall refer to an LED Luminaire and any power conditioning and/or interface equipment functioning together as a working unit.
- B. Thermal Management: The LED Luminaire manufacturer shall provide appropriate thermal management technology to ensure that temperatures do not exceed the limits established by the LED chip manufacturer. LED driver performance and compatibility with other light Luminaire components to be the tested and verified by the light Luminaire manufacturer.
- C. LED Luminaires: LED Luminaires shall provide a continuous light output. Luminaire output and dimensions shall be in accordance with the contract drawings and specifications. LED Luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED Luminaires to operate in ambient temperature of -20 degrees Celsius and +50 degrees Celsius. White LEDs to have a minimum life of 50,000 hours and color LEDs to a minimum of 1000,000 hours. Color changing Luminaires shall be capable of 8-bit control of differently colored LEDs to produce the specified range of colors. All LED Luminaire types shall be provided with complete photometric data including lumen output, lumen depreciation, life, and distribution.
- D. Performance Assessment: The performance of LED Luminaires shall be evaluated and reported according to IESNA standards LM-79 'Electrical and Photometric Measurements of Solid-State Lighting Products' and LM-80 'Measuring Lumen Maintenance of LED Light Sources'. The results of such evaluation shall be reported by the LED Luminaire manufacturer.
- E. Performance Requirements:
 1. Driver shall operate from 60 Hz input source of 120V thru 277V with sustained variations of +/- 10% with no damage to the driver.
 2. Driver output shall be regulated to +/- 5% across published load range.
 3. Power Factor: Greater than 90%.
 4. Total Harmonic Distortion: Less than 20%
 5. Sound Rating: Class A.
 6. Minimum operating temperature: -40 deg F.
 7. Ballast shall tolerate sustained open circuit and short circuit output conditions.
 8. Dimmable drivers shall be controlled by Class 2 low voltage 0-10V DC controller.
- F. Regulatory Requirements:
 1. Driver shall be UL listed, Class 2 Outdoor.
 2. Comply with ANSI C62.41 Category A for transient protection.
 3. Comply with ANSI C82.11

4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non consumer Class A for EMI/RFI (conducted and radiated).

2.07

EXIT SIGNS:

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Mount on standard 4-inch outlet boxes, unless otherwise noted.
- C. Internally Lighted Signs:

Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

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. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.08

EMERGENCY LIGHTING UNITS:

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or Luminaires.
Integral Time-Delay Relay: Holds unit on for fixed interval (per local code/minutes) when power is restored after an outage.

Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required

intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.09

LAMPS:

- A. All lamps in a source group must be provided/installed from the same manufacturer. A different manufacturer may be provided for each source group. Approved manufacturers are:
 - 1. General Electric
 - 2. North American Philips
 - 3. Osram/Sylvania
- B. Source groups are defined as incandescent, low voltage MR-16 incandescent, fluorescent, metal halide and high-pressure sodium. Linear T5, "biax", and compact fluorescent lamps shall all be provided by the same lamp manufacturer.
- C. LED "lamps" and drivers are not all required to be provided by the same LED lamp supplier. It is understood each lighting manufacture will source LEDs from different sub-vendors/suppliers.
- D. Comply with ANSI C78 series that is applicable to each type of lamp.
- E. Non-compact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid start circuits.
- F. Fluorescent lamps shall have a minimum of 82 CRI (Color Rendering Index) and a Color Temperature (degrees Kelvin) as specified in LAMP SCHEDULE.
- G. Lamp Seasoning – All fluorescent and metal halide lamps shall be seasoned/burned-in according to the lamp manufacturer's requirements. Fluorescent lamps with dimming ballasts shall be seasoned/burned-in according to the more stringent requirements of both the ballast manufacturer and the lamp manufacturer.
- H. LED Lamps: Luminaire manufacturer shall be required to provide adequate heat sinking and thermal management. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Lumileds, Osram Sylvania, Cree, Nichia, or as noted in the Luminaire schedule.
 - 1. White Light LEDS – Color temperature as specified. Minimum rated lamp life 50,000 hours.
 - 2. Colored LEDS - RGB LED systems to be controlled as noted. Minimum rated lamp life 70,000 hours.

2.10

FINISHES:

- A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

PART 3

EXECUTION

3.01

INSTALLATION:

- A. Set units plumb, square, and level with ceiling and walls, and secure according to

manufacturer's written instructions and/or approved Shop Drawings.

1. Support Luminaires according to requirements of Electrical Specification section "Basic Electrical Materials and Methods" and local seismic code requirements.
- B. Mounting: Mounting heights specified or indicated are to bottom of Luminaire for suspended and ceiling-mounted Luminaires and to center of Luminaire for wall-mounted Luminaires unless otherwise noted.
1. Where mounting heights are not noted on the Construction Drawings, obtain the exact mounting height for lighting Luminaires from NEO in writing, prior to electrical "rough-in" installation.
 2. Coordinate rough-in with the type, style, and pattern of the ceiling wall material being installed.
 3. All light Luminaires installed without NEO approved mounting height shall be relocated at the Contractor's expense.
- C. All recessed downlights (incandescent, LED, HID, compact fluorescent, etc.) must be installed so that the bottom of the throat is even with the finished ceiling plane.
1. The overlapping flange shall be fit flush to the ceiling plane/throat.
 2. No light leak shall be visible.
 3. All miscellaneous hardware and ceiling modifications necessary to accomplish the above shall be provided.
 4. Do not install luminaires or parts such as finishing plates and trims for recessed luminaires until all plastering and painting that may mar luminaire finish has been completed.
- D. Recessed and Semi-recessed Luminaires Supported to Structure: Luminaires must not be supported from the suspended ceiling support system if the Luminaire weight is more than the specified ceiling manufacturer's weight limits or in excess of 50 pounds or in violation of governing building codes, earthquake codes and ordinances.
- E. Grid-Type Fluorescent Luminaires must be supported by a minimum of 2 rods or wires from the structure to the light Luminaire and secured to the luminaire within 6 inches of the luminaire corners or as per governing building codes, earthquake codes and ordinances.
- F. Coordinate with other trades so luminaires are properly aligned with diffusers, grilles, speakers, etc. If necessary, relocate luminaires as directed so there will be no conflict with the other trades' equipment.
- G. Install earthquake clips for all lay-in grid type fluorescent luminaires, securely fastened to ceiling grid members, a minimum of one clip at or near each luminaire corner.
1. "Bend-out" style earthquake clips integral to the upper housing are only acceptable if permitted in writing by local building codes. This shall be done in addition to the light Luminaires being supported to structure with by a minimum of 2 rods or wires.
- H. Luminaires of Sizes Less than Ceiling Grid: Center in acoustical panel or as noted on architectural ceiling plan and detail drawings.

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1. Do not support Luminaires by ceiling acoustical panels or the ceiling suspension system.
2. Support Luminaires by a minimum of 2 rods or wires from the structure to at least two 3/4-inch (20-mm) metal channels spanning the ceiling suspension system supports.
3. The two channels shall be securely attached to the ceiling suspension system supports at all (4) four channel to grid intersection points with tie-down wire.

3.02 CONNECTIONS:

- A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.03 FIELD QUALITY CONTROL:

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
 1. Give advance notice of dates and times for field tests.
- B. Provide instruments to make and record test results.
- C. Tests: Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following information in tests of emergency lighting equipment:
 1. Duration of supply.
 2. Low battery voltage shutdown.
 3. Normal transfer to battery source and retransfer to normal.
 4. Low supply voltage transfer.
- D. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
- E. Report results of tests.
- F. Replace luminaires that show evidence of corrosion during Project warranty period.

3.04 LAMPING & LAMP REPLACEMENT

- A. Install proper number, type, and size lamp in luminaire as indicated on drawings.
- B. Relamp all luminaires in service during construction with new lamps prior to turning over the premises to the owner or give equivalent of new lamping to the Owner.

3.05 ATTIC STOCK LAMPS

- A. General: Provide attic stock of lamps at time of substantial completion to meet the following:

1. Provide attic stock lamps amounting to 15 percent (but not less than 6 lamps of each lamp type and wattage specified).
2. LED Replaceable Lamp Modules - Provide attic stock lamps amounting to 10 percent (but not less than 6 lamp modules and 6 drivers of each lamp type and wattage specified).
3. LED Non-Replaceable Lamp Modules - For luminaires where LED modules/boards are not field-replaceable by the Owner, provide attic stock consisting of entire LED Luminaire (and drivers) in quantities of 10 percent (but not less than 2 of each Luminaire).

3.06

CLEAN LUMINAIRES

- A. Clean: During construction, installation, clean luminaires of dirt and debris to insure proper performance and operational temperatures.
- B. At time of Substantial Completion, all luminaires must be clean of dirt and debris.
- C. Protection: Protect installed luminaires from damage during the construction period.

3.07

ADJUST LUMINAIRES

- A. Adjust: Aim, adjust, focus, and lock, all adjustable lighting units under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews required. All aiming and adjusting shall be carried out after the entire installation is complete. Furnish all ladders, scaffolds, etc. required at the direction of the lighting consultant. As aiming and adjusting is completed, locking mechanisms such as setscrews, bolts, and nuts shall be tightened securely.
- B. Targeting shall take place after sunset at a time designated by NEO.
- C. All labor and material costs made necessary by this requirement shall be included as part of the base bid.

END OF SECTION

SECTION 26 56 00 – EXTERIOR LIGHTING

PART 1 **GENERAL**

1.01 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary, apply to this Section.

- A. See Drawings for LUMINAIRE SCHEDULE for all luminaires specified by NEO Engineers Lighting.

1.02 SUMMARY

- A. Scope: The extent of exterior lighting required is indicated on the drawings and schedules and by the requirements of this Section, and all related Electrical Specification Sections.
- B. Furnish and install material, labor, and accessories required for the following pieces of equipment as shown on the drawings as specified herein.
- C. Types of luminaires specified in this Section are for outdoor use and include the following:
 - 1. Metal halide (MH)
 - 2. Fluorescent (FL)
 - 3. Compact Fluorescent (CFL) Luminaire
 - 4. LED
 - 5. Incandescent Luminaire
 - 6. Exit Signs
 - 7. Emergency Lighting Units
- D. Related Sections: Refer to other Electrical Specification sections for the following:
 - 1. See drawings for Luminaire schedule.
 - 2. Section 26 05 33 RACEWAYS & BOXES
 - 3. Section 26 05 19 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

1.03 SUBSTITUTIONS

- A. No substitutions will be accepted after bids are received. The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous performance requirements of this project.
- B. One Manufacturer or "Pre-Bid Approved Equal": When only one manufacturer is listed within the description of the luminaire, the engineering, performance, or aesthetics *MAY NOT* allow substitution of other manufacturers. "Pre-Bid Approved Equal" permits pre-bid submittal of a product for consideration under submittal guidelines established by this specification section.
- C. Three manufacturers: When three manufacturers are listed on the Luminaire Schedule, the design, engineering, or architectural aesthetics will allow the CONTRACTOR to choose one of the three manufacturers listed. The first manufacturer listed by name and catalog number is the basis of design. The second and third manufacturer's name will be noted along with the wording "EQUAL

PRODUCT” instead of a catalog number. The second and third listed manufacturer’s “EQUAL PRODUCT” shall be provided which meets or exceeds the manufacturer’s product noted with catalog number in materials, finish, components and accessories. NEO Lighting will have final opinion of “EQUAL PRODUCT” interpretation. Contractor/Distributor/Representative must formally submit questions in writing. All submittals must be in NEO Lighting possession not later than ten (10) business days before the bid opening. NEO Lighting will issue a formal written response thru official channels.

- D. Luminaire Substitutions / Substitution Packages: Contractor may elect to submit to NEO Lighting a luminaire substitution package for review. All submittals must be in NEO Lighting possession not later than ten (10) days prior to bid date. All luminaire substitutions must meet or exceed the following Substitution Submittal Requirements or will be rejected outright by NEO Lighting.
- E. Substitution Submittal Requirements: A luminaire substitution (substitution package) shall consist of the following information or will be rejected outright by NEO Lighting:
 - 1. Original luminaire cut sheet noting exact options/features of the proposed product in detail / dimensional accuracy.
 - 2. Color image of luminaire, in the configuration of the proposed product.
 - 3. Dimensioned drawing of luminaire to an identified scale per sheet print size.
 - 4. Electric data of the proposed luminaire with specified lamp, ballast, transformer, driver or power supply.
 - 5. IES format photometric files for the proposed luminaire with specified lamp.
 - 6. Photometric reports must list the actual candela values for the luminaires’ distribution in at least three planes. Copies of candela curves, footcandle and lumen tables and iso-footcandle contours must also include IES format electronic photometric files identified by NEO Lighting for each proposed luminaire type.
 - 7. Calculations - Substitutions for luminaire types impacting “calculation / light level sensitive” project rooms/areas must be submitted with a complete point by point calculation grid of the area utilizing the substituted luminaire and adjacent luminaires contributing to the light levels. The point by point submittal must include a statistical chart showing all fixed and variable calculation factors including, but not limited to: initial / maintained lamp lumens, all LLFs (Light Loss Factors), lamp/luminaire mounting heights, calculation plane height(s), surface reflectances, complete luminaire model numbers and calculation point spacing. Calculations will be rejected outright by NEO Lighting without this information. NEO Lighting reserves the right to obtain an electronic copy of the calculation files and the substitute luminaire IES files. NEO Lighting may run a comparison calculation model using AGi.
 - 8. LEED / ASHRAE - The project is required to conform to the lighting requirements of the LEED New Construction - Version 2.2 and ASHRAE / IESNA 90.1 / 2009.
- F. All substitution submittals shall be provided to NEO Lighting in two formats:
 - 1. Hard / paper copy: (1) one complete sets of hard/paper copy shall be provided to NEO Lighting in a green 3-ring binder. Included DVD/CD of all content in binder.
 - 2. Electronically posted files will be delivered thru Owner / Architect / Contractor established communication channels. No files shall be directly delivered to the NEO Lighting by vendors or their agents.

G. NEO Lighting Fee Compensation

1. CONTRACTOR will be responsible for all costs (architecture time, NEO Lighting time, engineering time, manufacturer's costs, distributor costs, etc.) incurred to replace installed lighting equipment not approved by NEO Lighting.
2. CONTRACTOR shall pay professional fees at current standard hourly rates and reimburse expenses directly to all design professionals for time spent reviewing substitutions proposed by the Contractor after the bid has been awarded. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
3. Additional fees will be required for all submittals / substitution reviews exceeding (3) shop drawing submittals per luminaire.

1.04

SUBMITTALS

- A. General: Furnish submittals in accordance with the requirements of the related section.
- B. Coordination: All luminaire drawings shall be coordinated with the drawings and details of the Architectural, Structural, Electrical, Mechanical, and other related trades to assure a perfect and efficient installation.
- C. No Variations: No variations from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance by the architect. All variations must be clearly marked on the drawings submitted for approval.
- D. Product Data describing luminaires, lamps, ballasts, and emergency lighting units.
 1. LEED Submittal Requirements: Provide the following which represents some of the submittal requirements outlined in "LEED Submittals" SECTION 013313. Please refer to this Section for additional requirements. Information pertaining to LEED requirements and definitions can be found in SECTION 018113 "Sustainable Design Requirements." Information pertaining to VOC limits, anticipated recycled content of materials, and other Standards utilized for compliance with the LEED standards are included in SECTION 016710 "Environmental Impact of Materials."
 2. Luminaire Shop Drawings: Submit legible, dimensioned drawings of specified lighting assemblies including:
 - a. Specified luminaire accessories, finishes, components on each sheet. If only the catalog number is provided without graphically identifying the exact Luminaire accessories, finishes, components on each sheet, the luminaire type will be REJECTED AS NOTED.
 - b. Modified or custom luminaires require a factory produced shop drawing. Standard Luminaire cut sheet annotated/noted as "modified" will not be permitted (even for lamping modification) the luminaire type will be REJECTED AS NOTED.
 - c. No hand-written notes are permitted on lighting shop drawing submittals or the luminaire type will be REJECTED AS NOTED.
 - d. Catalog cuts lacking sufficient detail to indicate compliance with

- contract documents with be REJECTED AS NOTED.
- e. Luminaires / ceiling systems - See other specification sections for ceiling systems.
- 1) Contractor responsible to coordinate luminaire and ceiling systems compatibility of hardware, trims and materials.
 - 2) Ceiling/Luminaire Trim contractor coordination must be noted as verified on each shop drawing by Contractor for luminaire in final approved/purchased ceiling type, which may be a ceiling system different than originally specified.
 - 3) One Luminaire type may be installed in multiple ceiling types requiring the following submittals.
 - a) A separate cut sheet must be provided for each luminaire and unique ceiling system noting coordination.
 - b) A spreadsheet/matrix of lighting Luminaire types and ceiling types coordinating above details.
 - 4) Contractor to provide Lighting Manufacturers will both CAD and face based REVIT files of the ceiling systems for luminaire compatibility/integration/coordination.
 - 5) Lamp shop drawings: "Lamp Schedule" matrix shall be submitted noting luminaire types and the lamp type designation / lamp manufacturer provided in each luminaire type. One (typical) lamp cut sheet for each unique lamp type shall be submitted for review / approval.
 - 6) Ballast shop drawings: "Ballast Schedule" matrix shall be submitted noting luminaire types and the ballast type designation/ballast manufacturer provided in each luminaire type. One (typical) ballast cut sheet for each unique ballast type shall be submitted for review/approval.
 - 7) Booklet format: Shop drawings shall be submitted in booklet form organized with a separate sheet for each grouping of luminaire, ballast matrix and typical cut sheets, lamp matrix and typical cut sheets, and Contractor's Luminaires / Ceiling Systems compatibility confirmation assembled in alpha-numeric order of luminaire "type" designation.
 - 8) Submittal format: Submittals shall be provided to NEO Lighting in two formats:
 - a) (1) one complete set of hard/paper copy shall be provided to NEO Lighting in green 3-ring binder. DVD/CD of all content in binder shall be included in each binder.
 - b) Electronically posted files will be delivered thru Owner / Architect / Contractor established communication channels. No files shall be directly delivered to NEO Lighting by vendors or their agents
3. Record Shop Drawings Required: Record luminaire, ballast and lamp shop drawings shall be delivered to the NEO Lighting at time of Substantial Completion. All "Approved as Noted" comments shall be corrected / picked-up in this record set. All shop drawing review comments shall be included in

- this set. Record luminaire shop drawings shall be three ring bound in a bright yellow or orange color binder and provided electronically on DVD/CD(s).
4. Luminaire Ordering Schedules and Shop Drawing Schedules: All lighting equipment shall be ordered in a timely manner. The Contractor shall provide a spreadsheet to NEO Lighting with the following detailed information organized by luminaire type:
- a. Originally quoted delivery dates (6-8 weeks, etc) from time of Bidding.
 - b. Shop drawings delivery dates to NEO Lighting.
 - c. Dates when equipment orders are placed / finalized per approved shop drawings.
 - d. Final product delivery schedules.
 - e. Long Lead Items - At time of original quote/bid, Contractor is required to identify any long lead lighting items and identify in the master project construction schedule for trade coordination.
- E. Battery and charger data shall be submitted for emergency lighting units.
- F. Electrical Ratings and Photometric Data with certified results of independent laboratory tests for luminaires and specified lamps.
- G. Field test reports, indicating and interpreting test results, specified in Part 3 of this section
- H. Maintenance Manual: Refer to Section 26 05 01 for general requirements. At the completion of the project, the luminaire manufacturer shall furnish to the owner a recommended maintenance manual. Each maintenance manual shall include:
1. Tools Required.
 2. Types of cleaners to be used.
 - a. Replacement parts identification lists.
 - b. Final as built shop drawings.
- I. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of NEO Lighting. All variations must be clearly marked as such on the drawings submitted for approval.

1.05

QUALITY ASSURANCE:

- A. Standards: Materials, equipment, and appurtenances as well as workmanship provided under this section shall conform to the highest commercial standard as specified and as indicated on drawings.
- B. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- C. Listing and Labeling: Provide luminaires, emergency lighting units, and accessory components specified in this section that are listed and labeled for their indicated use and installation conditions on Project.
- D. Special Listing and Labeling: Provide luminaires for use in damp and wet locations that are specifically listed and labeled for such use.

- E. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- F. Coordinate luminaires, mounting hardware, and trim with adjacent materials and other items, including work of other trades, required for installation. Confirm compatibility of luminaires with the final, as-ordered mounting materials/surfaces prior to ordering all luminaires. See SUBMITTAL section for required documentation.
- G. Codes and Standards: Provide luminaires and appurtenances conforming to the following:
 - 1. American National Standards Institute (ANSI):
 - a. C82.4 Ballasts for High-Intensity-Discharge
 - 2. Conform to applicable sections of American Society for Testing and Materials (ASTM)
 - a. B 429, "Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube."
 - 3. Conform to applicable sections of Certified Ballast Manufacturer's Association (CBM) standards for fluorescent lamp ballasts.
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. FA 1 Outdoor Floodlighting Equipment
 - b. OD 3 Physical and Electrical Interchangeability of Photo Control Devices
 - 5. Conform to applicable sections of National Fire Protection Association (NFPA) 70, "National Electrical Code."
 - 6. Underwriters Laboratories, Inc. (UL):
 - a. 57 Electric Lighting Luminaire
 - 7. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and Luminaires.

1.06

WARRANTY:

- A. General Warranty: The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

PART 2

PRODUCTS

2.01

MANUFACTURERS

- A. Subject to compliance of requirements, provide the products specified in the Luminaire Schedule.

2.02

LUMINAIRES

- A. General: Provide luminaires of the sizes, types and ratings indicated, complete with housings, lenses, louvers, refractors, lamps, lamp holders, reflectors, ballasts, starters, ignitors, mounting brackets or hardware with adjusting means and wiring.
- B. Housings: Provide luminaires with rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use. Provide housings free from burrs, sharp edges or corners. Provide filter/breather to minimize dirt buildup.
- C. Hinged Lens Doors: Provide captive hinged doors, operating freely, to allow lamp installation and removal without the use of tools. Equip door mechanism to preclude accidental falling of the door when opening or closing or when secured in the closed position. Provide for door removal for cleaning or replacing lens.
- D. Exposed Hardware: Provide stainless steel hinges, latches, fasteners, and exposed hardware to prevent corrosion of hardware or the staining of adjacent surfaces. Provide captive hardware on all exposed fasteners.
- E. Interior Reflecting Surfaces: Use interior formed and supported light reflecting surfaces having reflectances of not less than 85 percent for white surfaces, 83 percent for specular surfaces, and 75 percent for specular diffuse surfaces.
- F. Lenses and Refractors:
 - 1. Plastic: Plastic for clear lenses and diffusers shall be formed of colorless 100% virgin acrylic. The quality of the raw material shall meet or exceed IES, SPI, and NEMA specifications and shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded, or extruded, as specified and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 10 years.
 - 2. Glass: Glass used for exterior glass lenses shall use tempered Borosilicate glass unless otherwise noted.
 - 3. Mechanical: All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion does not cause them to drop out.
 - 4. Cleaning: Lenses shall be turned over to the owner clean and free of dust.
- G. Metal Finishes: Provide finishes of the color and type Indicated and having the following properties:
 - 1. Protection of metal from corrosion - 5-year warranty against perforation or erosion of the finish from weathering.
 - 2. Color retention - 5-year warranty against fading, staining, or chalking from weathering, including solar radiation.
 - 3. Uniformity - Provide finish of uniform thickness and color, free from streaks, stains or orange peel texture.
 - 4. Lamp Sockets: Provide lamp sockets complying with applicable UL and ANSI requirements.

2.03 COMPACT FLUORESCENT BALLASTS

- A. Acceptable Manufacturers:
 - 1. Advance Centium Series.
 - 2. Osram Sylvania Quicktronic Series.
 - 3. GE Ultrastart Series.

- B. Performance Requirements:
 - 1. Ballast shall be Programmed Start.
 - 2. Ballast shall contain auto restart circuitry in order to restart lamps without restarting power.
 - 3. Ballast shall operate from 50/60Hz input source of 120V thru 277V with sustained variations of +/- 10%.
 - 4. Ballast shall be high frequency type and operate at a frequency above 42kHz to avoid interference with infrared devices and eliminate visible flicker.
 - 5. Minimum Power Factor: 98 percent or greater for primary lamp.
 - 6. Ballast Factor: Minimum 1.0 for primary lamp.
 - 7. Lamp Current Crest Factor: 1.7 or less.
 - 8. Total Harmonic Distortion (THD) of Ballast Current: Less than 10 percent.
 - 9. Ballast shall have Class A sound rating.
 - 10. Ballast shall have a minimum starting temperature of 0°F.
 - 11. Ballast shall provide Lamp EOL(end of life) protection circuit.
 - 12. Ballast shall tolerate sustained open circuit and short circuit output conditions.

- C. Regulatory Requirements:
 - 1. Ballast shall be UL listed, Class P certified.
 - 2. Comply with ANSI C62.41 Category A for transient protection.
 - 3. Comply with ANSI C82.11
 - 4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non consumer Class A for EMI/RFI (conducted and radiated).
 - 5. Comply with UL Type CC rating.
 - 6. Comply with NEMA 410 for in-rush current limits.

2.04 LED LIGHTING SYSTEMS

- A. Complete System: The contractor shall furnish the completed LED-based lighting system. A 'Complete System' shall refer to an LED Luminaire and any power conditioning and/or interface equipment functioning together as a working unit.

- B. Thermal Management: The LED Luminaire manufacturer shall provide appropriate thermal management technology to ensure that temperatures do not exceed the limits established by the LED chip manufacturer.

- C. LED Luminaires: LED Luminaires shall provide a continuous light output. Luminaire output and dimensions shall be in accordance with the contract drawings and specifications. LED Luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED Luminaires to operate in ambient temperature of -20 degrees Celsius and +50 degrees Celsius White LEDs to have a minimum life of 50,000 hours and color LEDs to a minimum of 70,000 hours. All LED Luminaire types

shall be provided with complete photometric data including lumen output, lumen depreciation, life, and distribution.

- D. Performance Assessment: The performance of LED Luminaires shall be evaluated according to IESDNA standards LM-79 'Electrical and Photometric Measurements of Solid-State Lighting Products' and LM-80 'Measuring Lumen Maintenance of LED Light Sources'. The results of such evaluation shall be reported by the LED Luminaire manufacturer.
- E. Performance Requirements:
 - 1. Driver shall operate from 60 Hz input source of 120V thru 277V with sustained variations of +/- 10% with no damage to the driver.
 - 2. Driver output shall be regulated to +/- 5% across published load range.
 - 3. Power Factor: Greater than 90%.
 - 4. Total Harmonic Distortion: Less than 20%
 - 5. Sound Rating: Class A.
 - 6. Minimum operating temperature: -40 deg F.
 - 7. Ballast shall tolerate sustained open circuit and short circuit output conditions.
 - 8. Dimmable drivers shall be controlled by Class 2 low voltage 0-10V DC controller.
- F. Regulatory Requirements:
 - 1. Driver shall be UL listed, Class 2 Outdoor..
 - 2. Comply with ANSI C62.41 Category A for transient protection.
 - 3. Comply with ANSI C82.11
 - 4. Comply with Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18 non consumer Class A for EMI/RFI (conducted and Radiated).

2.05

EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Integral Time-Delay Relay: Holds unit on for fixed interval (per local code/minutes) when power is restored after an outage.
 - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.06

LAMPS

- A. All lamps in a source group must be provided / installed from the same manufacturer. A different manufacturer may be provided for each source group. Approved manufacturers:
 - 1. General Electric
 - 2. North American Philips
 - 3. Osram/Sylvania
- B. Source groups are defined as incandescent, low voltage MR-16 incandescent, fluorescent, metal halide and high-pressure sodium. Linear T5, "biax", and compact fluorescent lamps are collectively one source group and shall all be provided by the same lamp manufacturer.
- C. LED "lamps" and drivers are not all required to be provided by the same LED lamp supplier. It is understood each lighting manufacture will source LEDs from different sub-vendors/suppliers.
- D. Comply with ANSI C78 series that is applicable to each type of lamp.
- E. Fluorescent lamps shall have a minimum of 82 CRI (Color Rendering Index) and a Color Temperature (degrees Kelvin) as specified in LAMP SCHEDULE.
- F. Lamp Seasoning – All fluorescent and metal halide lamps shall be seasoned/burned-in according to the lamp manufacturer's requirements. Fluorescent lamps with dimming ballasts shall be seasoned/burned-in according to the more stringent requirements of both the ballast manufacturer and the lamp manufacturer.
- G. LED Lamps: Luminaire manufacturer shall be required to provide adequate heat sinking and thermal management. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Lumileds, Osram Sylvania, Nichia, or as noted in the Luminaire schedule.
 - 1. White Light LEDS – Color temperature as specified. Minimum rated lamp life 50,000 hours.
 - 2. Colored LEDS - RGB LED systems to be controlled as noted. Minimum rated lamp life 70,000 hours.
- H. Outdoor lamp holders shall be neoprene gasketed and compression type. Sockets with open circuit voltage over 300 volts shall be safety type designed to open supply circuit on lamp removal.

2.07

FINISHES:

- A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

2.08

LUMINAIRE MOUNTING

- A. General: Provide corrosion resistant metal luminaire mounting compatible with the luminaires that will not cause galvanic action at contact points. Provide mounting that will correctly position the luminaire to provide the required light distribution.

2.09 LIGHTING CONTROLS

- A. General: See section Electrical Specification Lighting Control Devices for additional information.

PART 3 **EXECUTION**

3.01 LUMINAIRE INSTALLATION

- A. General: Install exterior luminaires at locations and heights as indicated on the drawings, in accordance with the manufacturer's written instructions, applicable requirements of NFPA 70, ANSI C2 and with recognized industry practices to ensure that lighting installation fulfills requirements.
- B. Support: Fasten luminaires securely to indicated structural supports; and check to ensure that the required degree of freedom is provided to allow alignment or aiming of the Luminaires for indicated light distribution. Provide excavation and poured reinforced concrete pads as noted on the drawings and provide anchor hook-bolts, nuts and washers in conformance with the details and manufacturer's requirements.
- C. Condition: Clean exterior luminaires of dirt and debris upon completion of installation. Do not damage finishes or lens or refractor surfaces.
- D. Grounding: Provide equipment grounding connections using branch circuit equipment and connected sufficiently tight to assure a permanent and effective ground.

3.02 INSTALLATION OF LIGHTING CONTROLS

- A. General: Install lighting controls as indicated on the drawings and specifications and in accordance with manufacturer's written instructions.
 - 1. Controls: Connect lights to controls furnished under specification section.
 - 2. Adjustment: Provide two visits to the project within the 12 months of project Substantial Completion date to adjust or reset lighting controls.
 - a. Visit One shall occur 3 months after Substantial Completion.
 - b. Visit Two shall occur 11 months after Substantial Completion.
 - c. At a minimum, both visits require the following individuals to accompany the Contractor.
 - d. The local lighting controls sales representative and lighting controls factory trained service technician will be required at both visits.

3.03 TESTS AND DEMONSTRATIONS

- A. General: Upon completion of installation and after energizing branch supply circuitry, apply electrical energy to luminaires to demonstrate compliance with requirements.
 - 1. Check footcandle levels and uniformity of illumination.
 - 2. Check for excessive ballast noise.
 - 3. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.04 LAMP REPLACEMENT

- A. General: At time of substantial completion, replace lamps in luminaires which are observed to be not functioning properly after Contractor's use and during construction.

3.05 ATTIC STOCK LAMPS

- A. General: Provide attic stock of lamps at time of substantial completion to meet the following:
 - 1. Provide attic stock lamps amounting to 15 percent (but not less than 6 lamps) of each lamp type and wattage specified.
 - 2. LED Replaceable Lamp Modules - Provide attic stock lamps amounting to 5% percent (but not less than 2 lamp modules and 2 drivers) of each lamp type and wattage specified.
 - 3. LED Non-Replaceable Lamp Modules - For luminaires where LED modules/boards are not field-replaceable by the Owner, provide attic stock consisting of entire LED Luminaire (and drivers) in quantities of 5 percent (but not less than 2 of each Luminaire).

3.06 CLEAN LUMINAIRES

- A. Clean: During construction, installation, clean lighting Luminaires of dirt and debris to insure proper performance and operational temperatures. At time of Substantial Completion, all luminaires must be clean of dirt and debris.
- B. Protection: Protect installed Luminaires from damage during the construction period.

END OF SECTION

SECTION 27 05 28 – PATHWAYS AND COMMUNICATIONS SYSTEMS

PART 1 **GENERAL**

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. General Provisions: Section 26 05 01
- B. Raceways and Boxes: Section 26 05 33
- C. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19

PART 2 **PRODUCTS**

2.01 PLYWOOD MOUNTING BOARDS

Provide 3/4" thick, flame retardant, plywood terminal boards for telephone service entrance and satellite boards sized as indicated on drawings.

2.02 CONDUIT REQUIREMENTS

- A. Provide underground conduit for service and distribution as indicated on the drawings.
- B. Provide 3/4" blank conduit concealed in walls and stubbed up above ceiling. Terminate with insulated bushing.
- C. Provide pull cord in all telephone/data conduits.

PART 3 **EXECUTION**

3.01 GENERAL

Install all conduit in accordance with Specifications Section 26 05 33, Raceways and Boxes.

END OF SECTION

SECTION 28 31 00 – FIRE DETECTION AND ALARM

PART 1: GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Electrical General Provisions: Section 26 05 01
- B. Low Voltage Electrical Power Conductors and Cables: Section 26 05 19
- C. Raceways and Boxes for Electrical Systems: Section 26 05 33

1.02 WARRANTY

For warranty information see Section 26 05 01, Electrical General Provisions.

1.03 SCOPE OF WORK

New devices to match existing connected to existing system.

1.04 SUBMITTALS

Submit shop drawings on all fire alarm system components as well as complete field wiring diagrams and floor plans in accordance with Specification Section 26 05 01, Electrical General Provisions.

1.05 SYSTEM DESCRIPTION

- A. System is a microprocessor based fire alarm control panel, addressable alarm initiating devices (manual stations, automatic smoke detectors, duct smoke detectors and thermodetectors), alarm signaling devices, annunciators, programmable output relays in control panel and digital communicator for contacting a central supervising location.
- B. System shall be closed circuit, electronically operated, with short and open wiring faults, causing audible and visual trouble indication at the control panel. The initiating devices shall be wired in a loop configuration to allow each device or master device to be assigned an individual address.
- C. Actuation devices shall be displayed at the control panel according to the following identification system: Any detection device shall carry its own address which shall be displayed on a digital display by number. The zone/loop and the group (i.e. area, device type, etc. as programmed) to which it belongs shall be displayed by an LED.
- D. An adequate number of control relays shall be provided to interface to temperature control equipment, elevator equipment, air handling equipment or other controls to provide auxiliary operations. It shall be possible to operate these relays from different sections of the system as follows: Outputs and/or relays shall be available that are sector specific (i.e. zone/loop) such as FIRE, TROUBLE, SUPERVISORY.

- E. The fire alarm system shall be provided with remote annunciator panels. Data shall be multi-plexed from the control panel to each annunciator to reduce wiring requirements. Coordinate final location with Owner=s Representative and local fire department.
- F. Acceptable Manufacturers (same as existing)

1.06 SCOPE AND RELATED DOCUMENTS

- A. The work covered by this section of the specifications includes the furnishings, equipment, materials, and performance of all operations associated with the installation of an addressable microprocessed fire alarm system as shown on the drawings and as herein specified.
- B. The complete installation shall conform to the applicable sections of NFPA 72A, 72B, 72C, 72D Local Code Requirements and National Electrical Code with particular attention to Article 7~0.

1.07 QUALITY ASSURANCE

- A. Each and all items of the fire alarm system shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriter's Laboratories Inc., (UL), and shall bear the UL label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.
- B. All control equipment must have transient protection to comply with UL896 requirements.
- C. In addition to the UL-UOJZ requirements mentioned above, the system controls shall be UL listed for Power Limited Applications and all circuits must be marked in accordance with NEC article 760-23.

1.08 SEQUENCE OF OPERATION

- A. Upon activation of an any alarm initiating device, the following shall occur:
 - 1. Audio/visual alarm shall occur throughout the building.
 - 2. The alarm shall be annunciated by floor and device type on the building fire alarm control panel.
 - 3. The alarm shall be annunciated at the remote annunciator.
 - 4. The supervising location shall be contacted.
 - 5. The air handling equipment serving the area in alarm shall shut down.
 - 6. Contact closures will interface to the temperature control system for the following alarms:
 - a. Fire Alarm
 - b. Fire Alarm System Trouble
 - c. Sprinkler Flow Alarm
- B. Upon activation of sprinkler supervisory switch, or a system trouble, the following shall occur:
 - 1. The fire alarm control panel shall show system trouble.
 - 2. The fire alarm remote annunciator shall show system trouble.

PART 2: PRODUCTS

2.01 ADDRESSABLE BASES OR DETECTORS

- A. If required, addressable devices shall be provided for interfacing with base-compatible photo electronic and thermal-type detectors.
- B. The addressable device shall contain an addressable element which is monitored by a serial polling operation.
- C. The device's addressable element shall be encapsulated to insure protection against environmental contaminants.
- D. The addressable device shall incorporate an integral pulsing alarm LED for quick recognition of the alarming device. The base shall have the capability of supporting a remote pulsing LED.
- E. Manual Pull Station
 - 1. Addressable Pull Stations (Manual Fire Alarm Boxes): Addressable pull stations shall contain electronics that communicate the station's status (alarm, normal) to the control panel over two wires which also provide power to the pull station. The address shall be set on each station. The stations shall be manufactured from high impact red Lexan. Lettering shall be raised and painted white. The station shall mechanically latch upon operation and remain so until manually reset. Pull stations shall be single action.
 - 2. All pull stations shall have 2 inch white label with red lettering stating the digital address of the device. Mount label at top of pull station.

2.02 PHOTOELECTRONIC SMOKE/HEAT DETECTORS

The smoke detector shall be of the solid state photoelectronic type and shall operate on the light scattering, photodiode principle. The detector shall be factory set to detect smoke at a nominal 1.5% light obscuration per foot regardless of the rate of combustion. To minimize nuisance alarms, detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. All smoke detectors shall be equipped with self compensating circuitry to provide maximum stability against effects of aging, dust and film accumulation.

The detector light source shall be an LED. The detector shall be equipped with a pulsed LED power supervisory indicator. The detector shall be designed to latch into alarm following a 6 to 10 second signal processing delay verifying the continued presence of smoke within the sensing chamber. An alarm condition shall be indicated by a steady red glow from the LED indicator. Smoke detectors shall have an integral fixed temperature heat detector rated at 135°F as indicated. Heat detector shall operate the alarm circuit and illuminate the smoke detector "Alarm" indicator lamp. A calibrated test feature shall be provided capable of simulating a maximum acceptable amount of smoke for alarm. The test feature shall provide individual local testing of the detector. For ease of maintenance and installation, detectors shall be designed for twist-lock mounting to a separate base assembly having screw terminals for external wire connections.

2.03 AIR DUCT DETECTORS

The duct smoke detector shall be of the solid state photoelectronic type and shall operate on the light scattering, photodiode principle. The detector shall be factory set to detect smoke at a nominal 1.5% light obscuration per foot regardless of the rate of combustion. To minimize nuisance alarms, detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. All smoke detectors shall be equipped with self compensating circuitry to provide maximum stability against effects of aging, dust and film accumulation. The detector light source shall be an LED. The detector shall be equipped with a pulsed LED power supervisory indicator. The detector shall be designed to latch into alarm following a 6 to 10 second signal processing delay verifying the continued presence of smoke within the sensing chamber. An alarm condition shall be indicated by a steady red glow from the LED indicator. Air duct detector will be installed in ventilating duct as indicated in the manufacturer's instructions. Air sampling tubes shall conform to dimensions of air duct construction and shall be constructed of 1/2" EMT tubing. Provide a remote alarm lamp as indicated on the drawings. Detectors shall be installed for supply ducts at furnaces F-1, F-2, F-3, F-4 F-5 and F-6 and air handling AHU-1.

2.04 THERMAL DETECTORS

- A. The addressable thermal detectors shall be of the rate compensated fixed temperature type (135CF) and shall be listed by Underwriters Laboratories, Inc.
- B. The addressable thermal detectors shall be individually annunciated on the control panel. The addressable thermal detectors shall contain an integral alarm lamp.

2.05 SPRINKLER SYSTEM INITIATING DEVICES

- A. Sprinkler system initiating devices are to be furnished and installed by the fire protection system piping trades in accordance with Division 23 of the specifications. Sprinkler system initiating devices include, but are not limited to PIV, OS&Y, and butterfly valve tamper switches, flow switches, air pressure monitoring switches and fire pump supervisory switches.
- B. Sprinkler system initiating devices shall be connected to compatible addressable interface devices that are connected to the fire alarm system.

2.06 ADDRESSABLE AUXILIARY INTERFACE

- A. The addressable auxiliary interface device shall provide for monitoring and interfacing normally open, latching alarm contacts or normally closed latching trouble contacts to the addressable system, via a separate Class B circuit.
- B. The auxiliary interface device shall contain an addressable element which is monitored by a serial polling operation.
- C. The auxiliary interface device's addressable element shall be encapsulated to insure protection against environmental contaminants.
- D. The addressable auxiliary interface device shall be capable of occupying the same initiating circuit along with other addressable devices.

2.07 ADDRESSABLE CONTROL INTERFACE

- A. The control interface shall contain an addressable element which is monitored by a serial polling operation.
- B. The control interface's addressable element shall be encapsulated to insure protection against environmental contaminants.
- C. The addressable control interface shall be capable of occupying the same initiating circuit along with other addressable devices.

2.08 ADDRESSABLE MANUAL ALARM STATION

- A. The body of the addressable manual alarm station shall be hinged to a backplate assembly to which it is locked by a head screw. Resetting the station after operation shall require opening the front cover for access to the alarm switch.
- B. Single action non-coded addressable manual alarm station shall be fitted with a pull lever which, when operated, locks in position after activating an alarm initiating contact.
- C. The non-coded, addressable manual alarm station shall be adaptable for surface or semi-flush installation.
- D. The non-coded, addressable manual alarm station shall be capable of occupying the same initiating circuit along with other addressable devices.
- E. The non-coded, manual alarm station's addressable element shall be encapsulated to insure protection against environmental contaminants.

2.09 COMBINATION AUDIO/VISUAL SIGNALING DEVICES

- A. Horn (Audio Portion): The horn shall be capable of providing a minimum audio output of 94 dB at a distance of 10 feet. Horn circuit shall be supervised.
- B. Strobe (Visual Portion):
 - 1. The lamp shall be a xenon strobe type or equivalent.
 - 2. The color shall be clear or nominal white and "fire" shall be imprinted on lens in red letter.
 - 3. The maximum pulse duration shall be two-tenths of one second (0.2 sec) with a maximum duty cycle of 40 percent. (The pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.)
 - 4. The intensity shall be a minimum of 75 candela.
 - 5. The flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz.
 - 6. The appliance shall be placed 80 inches above the highest floor level within the space of 6 inches below the ceiling whichever is lower.
 - 7. In general, no place in any room or space required to have a visual signal appliance shall be more than 50 feet from the signal (in the horizontal plane). In large rooms and spaces exceeding 100 feet across, without obstructions 6 feet above the finish floor, such as auditoriums, devices may be placed around the perimeter, spaced a maximum 100 feet apart.
 - 8. No place in common corridors or hallways in which visual alarm signaling appliances are required shall be more than 50 feet from the signal.

2.10 NON-SYSTEM SMOKE DETECTORS:

- A. Single-Station Smoke Detectors:
 - 1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 - 2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
 - 3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
 - 4. Visible Notification Appliance (where indicated): 177-cd strobe.
 - 5. Test Switch: Push to test; simulates smoke at rated obscuration.
 - 6. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 - 7. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 8. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - 9. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
 - 10. Detector to be used for tandem interconnection shall connect wirelessly and shall be by 'Kiddie Model i12040'.

PART 3: EXECUTION

3.01 GENERAL

- A. All wiring in areas exposed to view shall be in EMT conduit. Wiring in concealed areas may utilize plenum rated cable. Wiring shall run concealed in walls or above ceilings and shall be in strict accordance with the manufacturer's wiring diagrams and when complete, shall test free from opens, shorts and grounds and be in proper operating condition.
- B. All of the actual wiring is not shown as this may vary between acceptable suppliers. It shall be the responsibility of the Contractor to obtain this information from the acceptable suppliers and include cost of same in his bid.
- C. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be permitted in fire alarm conduits. Wiring splices are to be avoided wherever possible, but if needed they must be made only in junction boxes and shall be crimp connected. Transposing or changing color coding of wires not permitted. Wire nut-type connections are not acceptable. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc. shall be clearly labeled on all equipment panels. All wiring shall be checked and tested to insure that there are no grounds, opens or shorts.
- D. Contractor shall show evidence of having successfully completed at least three similar projects. Installation shall be performed by or under the supervision of factory authorized distributor.

- E. Preparatory work required to accommodate installation (i.e. conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required) shall be furnished and installed under this contract
- F. It shall be the responsibility of Division 26 contractor to wire and connect the waterflow and the valve supervisory switches as required by the Fire Marshal and by the existing conditions.
- G. Contractor shall coordinate locations of smoke detectors with HVAC diffusers so that no smoke detector is within 3 feet of diffuser.

3.02

TEST AND REPORTS

- A. A person or company who has written authorization from the manufacturer to act as an agent for the manufacturer shall make these tests. He need not necessarily be a person from the factory; he can be a dealer who has a letter from the manufacturer stating that he is qualified and has the proper instruments to make such tests. Perform all tests in the presence of the Owner or a person whom the Owner has elected to represent him. The Contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's form.
- B. This must be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable. All test and report costs shall be in the Contract price. A checkout report shall be prepared by the installation technician and submitted in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
 - 1. A complete list of equipment installed and wired.
 - 2. Indication that all equipment is properly installed and functions and conforms with these specifications.
 - 3. Test area and duct mounted smoke detectors with smoke or freon or test instrument. All detectors to be measured in place with the HVAC system operating.
 - 4. Test the system in five random zones by causing shorts, grounds and open circuits to ascertain the proper function of the supervisory system and trouble light(s).
 - 5. Serial numbers, locations by zone and model number for each installed detector.
 - 6. Voltage (sensitivity) settings for each ionization and photoelectric smoke detector.
 - 7. Technicians name, certificate number and date.
 - 8. All installed devices to be tested per function.
- C. At the time of the test provide the Owner or his representative with an oral explanation of the operation of the system. After completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the Owner with a copy to the Engineer.
 - 1. 'Record' conduit layout diagrams including wire color code and/or tag number.
 - 2. Complete 'record' wiring diagrams.
 - 3. Detailed catalog data on all installed system components.
 - 4. Copy of the Test Report.

5. A cover letter, for the above mentioned tests, certifying the entire fire alarm system parts, application and installation meets or exceeds the recommendations of the manufacturer.

3.03 HARDWARE/SOFTWARE AVAILABILITY

- A. The manufacturer shall guarantee hardware availability, including mechanical components, over a period of ten (10) years.
- B. The manufacturer shall guarantee software (program packages) availability, including updated versions (compatible), over a period of ten (10) years.
- C. All equipment required to update field programmability or equipment shall be supplied under the specification.

3.04 GUARANTEE

- A. Contractor shall guarantee all labor, material, equipment and wiring to be free of mechanical and electrical defects for a period of two (2) years from date of completion of the installation. Manufacturer shall furnish, gratis to Owner, a two-year contract effective from the date of acceptance for maintenance and inspection service of manufacturer's equipment. There shall be a minimum of four (4) inspections during contract years. Test and record all devices per manufacturer's requirements or every 6 months whichever is least. This contract for preventative maintenance will be made renewable to Owner after gratis years for standard fee.
- B. Contractor shall maintain adequate supply of spare parts and full time service facility with factory trained service technicians and shall guarantee that replacement parts will be available 24 hours after notification.
- C. Upon completion of installation and after satisfactory testing of system by Contractor in presence of equipment supplier, Contractor shall test the system in presence of Engineer and Owner's Representative.

3.05 FIRE ALARM CONDUIT

- A. Interior concealed dry spaces
 1. RGS, IMC, or EMT
 2. Where otherwise directed on drawings, or with Engineers approval, plenum rated, MC type cable specifically manufactured for use with Fire Alarm Systems shall be used in interior concealed dry spaces (MC-FPLP). Jacket shall have red coloring.
- B. Interior exposed, or in moist locations RGS or IMC shall be used.

END OF SECTION

SECTION 31 11 00 – SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Clearing and grubbing.
 - 2. Topsoil stripping and stockpiling.
- B. Related Sections:
 - 1. Division 31 Section "Earthwork".
 - 2. Division 31 Section "Erosion Control".

1.2 SUBMITTALS

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

1.3 PROTECTION

- A. Description:
 - 1. Protect existing site improvements to remain.
 - 2. Damage or destruction of items intended to remain shall be repaired or replaced to the satisfaction of the Owner, without additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Marking: Bright surveyor's tape.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordination and Verification:
 - 1. Contact Owner prior to clearing and grubbing to verify items of salvage.
 - 2. Also verify all existing trees, landscaping and other items or areas which are to remain, and which are to be cleared.

- B. Dust Prevention: Use water sprinkling and other necessary means to prevent dust from becoming a nuisance to the Owner, public or concurrent performance of the work.
- C. Limits:
 - 1. Limits of clearing and grubbing shall be the construction limits as shown on the Drawings or indicated and implied by the Contract Documents.
 - 2. If any clarification of limits is necessary, contact Owner and Architect/Engineer.
 - 3. If any work is necessary outside the contract limits, contact Owner and Architect/Engineer for approval prior to work.
- D. Clearing:
 - 1. Clean the site of all boulders, trash and debris as indicated and necessary.
 - 2. Remove items and materials indicated on Drawings to be removed.
 - 3. At areas to be covered by paving, walks, curbs, mechanical and electrical items, and where existing surfaces will be graded to new elevations, remove all trees, shrubs and other vegetation as required for installation of Work.
 - 4. Refer to Drawings for additional trees, shrubs and other vegetation to be removed.
 - 5. Saw damaged tree limbs clean and apply tree wound paint.
- E. Grubbing:
 - 1. Unless partial removal is indicated, remove all items to their full depth.
 - 2. Where partial removal is indicated or is practical, make straight and neat cuts in existing materials.
 - 3. Remove all stumps, roots over 2" in diameter, and matted roots within the limits of grubbing to the following depth from finish grading:
 - a. Footings: 18" or as required to provide construction clearance.
 - b. Walks: 12".
 - c. Roads: 18".
 - d. Parking areas: 12".
 - e. Lawn areas: 8".
 - 4. Apply tree wound paint to all cut ends of remaining stumps or roots to prevent regrowth.
- F. Removal and Disposal:
 - 1. Remove all logs, stumps, roots, cuttings, and other material as a result of clearing and grubbing daily as it accumulates and legally dispose of off-site.
 - 2. Burning of these materials on the site is not permitted.
- G. Completion of Work: Remove barricades at completion of work and ensure site is clean and free from debris.

3.2 EXCAVATION

- A. Install shoring or other protective support systems to minimize sloping or benching of excavations.

3.3 REGRADING

- A. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single un-compacted layer and hand grade to required finish elevations.
- B. Moderate Fill: Where existing grade is more than 6 inches, but less than 12 inches, below elevation of finish grade, place drainage fill, filter fabric, and topsoil on existing grade as follows:
 - 1. Carefully place drainage fill against tree trunk approximately 2 inches above elevation of finish grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within drip-line perimeter, place drainage fill up to 6 inches below elevation of grade.
 - 2. Place filter fabric with edges overlapping 6 inches minimum.
 - 3. Place fill layer of topsoil to finish grade. Do not compact drainage fill or topsoil. Hand grade to required finish elevations.

END OF SECTION

SECTION 31 20 00 - EARTHWORK

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Excavation, filling, backfilling and compacting.
2. Trenching and trench backfilling.
3. Mass earthwork and rough grading.
4. Finish grading, including spreading of topsoil.
5. Dewatering.
6. Soil stabilization.
7. Testing and inspection.

B. Related Sections:

1. Division 00 Section "Geotechnical Data".
2. Division 02 Section "Selective Site Demolition".
3. Division 31 Section "Site Clearing".
4. Division 31 Section "Erosion Control".

I.2 QUALITY ASSURANCE

A. Testing and Inspection:

1. All testing and inspection shall be performed by an independent Geotechnical Engineering Consultant ("Geotechnical Engineer").
2. The Geotechnical Engineer is responsible for all testing, sampling and inspection.
3. The Geotechnical Engineer is responsible for approving materials, installation and procedures.
4. The Contractor is responsible for providing these services.
5. The Contractor is responsible for all coordination and scheduling with the Geotechnical Engineer.

B. Topsoil:

1. All topsoil shall be tested and approved by the Soil Scientist.
2. Refer to I.3 Submittals for more information.

C. Any work in public right-of-way or other areas subject to the jurisdiction of anybody shall be performed either to the requirements of that jurisdiction or to the requirements of this Specification, whichever is more stringent.

I.3 SUBMITTALS

A. All submittals shall be reviewed and approved by Architect/Engineer and Geotechnical Engineer.

B. Product Data and Test Reports:

1. Field and laboratory tests and inspections.
2. Drainage file: Include material specifications and sieve analysis. Include signed material certificate from manufacturer/supplier.
3. Chemical modification: Include material specifications and signed material certificate from manufacturer/supplier.
4. Geo-synthetic materials: Include material specifications and signed material certificate from manufacturer/supplier.

C. Topsoil:

1. Furnish topsoil analysis performed by a soil scientist.

Approved Vendors:

- a. A&L Greatlakes Laboratories at 3505 Conestoga Dr. Fort Wayne, IN 46808.
 - a) Lawn and Garden Complete test with fertilizer recommendation codes 102, 114 and 118 selected.
- b. Lawn & Garden Soil Analysis at 682 North Pleasant Street, University of Massachusetts, Amherst, MA 01003.

2. Analysis shall state the following: (Refer to Part 2 for minimum requirements)

- a. Percentage of organic matter.
- b. Gradation of sand, silt and clay, Include USDA textural classification.
- c. Cation exchange capacity.
- d. Deleterious material.
- e. ph.
- f. Mineral and plant nutrient content (phosphorus, potassium, magnesium, calcium).
- g. Any requirements or recommendations necessary to make it suitable.
- h. Annual nutrient requirements and recommendations for evergreens shrubs, trees, and flowers.
- i. Soil test results without recommendations will be rejected. If using A&L request fertilizer recommendation for the following codes
 - a) 102 Lawn Seeding and Establishment
 - b) 114 Broadleaf Shrubs
 - c) 118 Shade Trees

3. This analysis is required for both on site and off-site topsoil.

4. Samples of the topsoil shall be taken under the following conditions:

- a. Within four (4) weeks prior to placing topsoil, take three representative samples of proposed topsoil.
- b. Within one week after placing topsoil, take three representative samples of in-place topsoil.

- c. All samples shall be taken at the witness of the Owner, in areas approved by the Owner. Contractor to coordinate with Owner as required.
5. Provide copies of all topsoil analysis and recommendations to Owner and Architect/Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. All soil materials shall be approved by the Geotechnical Engineer.
2. All soil materials shall be suitable for each application.
3. Suitable soils are defined as soils which provide proper strength, compaction and drainage requirements and which are approved by the Geotechnical Engineer.
4. Fill material which is unsuitable due to excess moisture will not be classified as unsuitable if it can be dried to optimum moisture specified herein by manipulation, aeration or blending with other materials satisfactorily as approved by the Geotechnical Engineer.

B. Fill Materials:

1. Note: The following describes fill materials and their application for use. The materials shall be used for the listed applications, unless designated otherwise on the Drawings. If the Contractor has any questions or concerns regarding the materials or intended application, contact the Architect/Engineer for directions. Compaction requirements are the percentage of maximum dry density per ASTM D698 Standard Proctor Test, unless noted otherwise in the Geotechnical Report.
2. General fill:
 - a. Suitable on-site or off-site fill material free of debris, roots, organic and frozen materials, and stones having a maximum dimension of 2".
 - b. Minimum compaction: 95%.
 - c. Application: General filling and backfilling of excavations and trenches outside of the building.
3. Structural fill:
 - a. Suitable on-site or off-site fill material free of debris, roots, organic and frozen materials, and stones having a maximum dimension of 2".
 - b. Minimum compaction: 100%.
 - c. Application: Compacted subgrade under buildings, foundations and areas subject to structural loads.
4. Granular fill:
 - a. Clean, natural or manufactured sand per requirements of INDOTSS Type "B" borrow, 4.75mm (No. 4) gradation. Pea gravel is not acceptable.
 - b. Minimum compaction: 95%.

- c. Application: Backfilling of excavations and trenches which are under or within 5' of pavement, and underneath exterior concrete pavement, walks, curbs and slabs on grade.
- 5. Drainage Fill:
 - a. General: Clean, washed fill sand with 100% passing the 4.75mm (No.4) sieve and no more than 5% passing the 0.075 mm (No. 200) sieve. Pea gravel or #53 stone are not acceptable.
 - b. Minimum compaction: 95%.
 - c. Application: Free draining material required for applications such as the outside of basement walls, the back side (earth side) of retaining walls and building slabs on grade.
- 6. Aggregate fill: Unless otherwise indicated, shall meet the following:
 - a. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone and natural or crushed sand.
 - b. ASTM D2940, with 100 percent passing a 1 1/2 inch sieve and not more than 8 percent passing a No. 200 sieve.
 - c. Application: base course under concrete and other items per plans.
- C. Topsoil:
 - 1. Topsoil shall be fertile, friable, natural surface soil obtained from well-drained areas and possessing characteristics of representative soils in the project vicinity that produce heavy growths of crops, grass or other vegetation.
 - 2. Topsoil shall consist of friable loam, reasonably free of subsoil, clay lumps, brush, roots, weeds or other objectionable vegetation, stones or similar objects larger than 1-1/2" in any dimension, litter or other materials unsuitable or harmful to plant growth.
 - 3. Supplement on-site topsoil with off-site topsoil as necessary.
 - 4. Unless otherwise indicated, minimum compacted thickness in lawn areas is 4".
 - 5. The mechanical analysis of topsoil shall be as follows:
 - a. 1" mesh sieve size; 99%-100% passing.
 - b. 1/4" mesh sieve size: 97%-99% passing.
 - c. No. 100 mesh sieve size: 40%-60% passing.
 - d. No. 200 mesh sieve size: 20%-40% passing.
 - 6. The following minimum requirements shall also be met:
 - a. Organic matter: 3-5%.
 - b. pH: 6.5 to 7.3.
 - c. Sand, silt, clay content: per USDA loam textural classification.
 - d. Minerals and nutrients: Per Geotechnical Engineer or Soil Scientist recommendations and amendments suitable for use in local area.
- D. Soil Separator Fabric:
 - 1. Nonwoven, needle-punched geotextile fabric manufactured from polyolefins or polyesters per ASTM M288, suitable for subsurface drainage and other specified applications.

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2. Application: subsurface drains and as specified in Contract Documents.
3. Specifications (values based on Mirafi 140N):
 - a. Apparent opening size: 70 (U.S. Standard Sieve Size); ASTM D-4751-99A.
 - b. Flow rate: 135 gpm/sf; ASTM D-4491-99A.
 - c. Puncture strength: 65 lbs; ASTM D-4833-00.
 - d. Mullen Burst: 225 lb/sq. in.
 - e. Grab tensile/elongation: 155 lbs/50%.
 - f. UV Resistance: 70% at 500 hours.
- E. Geo-synthetic Reinforcement:
 1. General: H-Series HX165 Geogrid as manufactured by Tensar International Corp., Atlanta Georgia.
 2. Application: Soil stabilization as required and as recommended by the Geotechnical Engineer.
- F. Chemical Modification:
 1. General: INDOTSS 215.
 2. Materials: Hydrated lime per INDOTSS 913.04(b) and Type I Portland cement per INDOTSS 901-01(b).
 3. Quantity: 4.0 +/- 0.5% by dry unit mass of the soils.
 4. Application: If Geotechnical report indicates that chemical modification may be needed for soil stabilization, then the Contractor shall include provisions for chemical modification in their bid.
- G. Other Materials:
 1. All other materials not specifically described but not required for proper completion of the Work of this Section, shall be selected by the Contractor subject to the approval of the Architect/Engineer and Geotechnical Engineer.

PART 3 - EXECUTION

3.1 REQUIREMENTS

- A. General:
 1. Weather: Do not perform earthwork activities during inclement weather.
 2. Dust: Use all necessary and appropriate means, such as water sprinkling, as required to prevent dust from being a nuisance to the Owner, public and concurrent performance of other work on the site.
 3. Conflicts: Should the preceding job conditions or other items specified herein because of actual or possible conflicts, notify the Architect/Engineer immediately and do not proceed until such conflict has been resolved.
 4. Refer to Division 31 Section "Termite Control" for termite protection requirements.
- B. Preparation: Verify that the following has been completed prior to beginning earthwork:

1. Protective fencing has been installed for trees and vegetation to remain.
2. Site clearing (clearing and grubbing).
3. Selective site demolition.
4. Erosion and sediment control measures are in place.

C. Protection:

1. For items indicated to remain, provide protection to prevent damage from construction activities. Any damage or destruction to items intended to remain intact shall be repaired or replaced to the satisfaction of the Owner at the Contractor's expense.
2. Topsoil: Protect placed topsoil from heavy machinery traffic. Remove and replace topsoil that is compacted by heavy machinery traffic.
3. Subgrade: Ditches and drains along the subgrade shall be maintained to always drain effectively. Repair subgrade of any ruts that may occur by reshaping and recompact as required.
4. Utilities: Determine locations of existing utilities and the extent to which they may affect earthwork operations. Where service and utility lines are to remain, provide protection to prevent damage or disruption of services.
5. Damaged utilities shall be repaired immediately at the Contractor's expense.
6. Open excavation:
 - a. The Contractor is responsible for ensuring all open excavations are properly barricaded and always protected. This includes work such as mass excavation and trenching and includes other potentially dangerous conditions such as retention ponds.
 - b. Provide and install all necessary and appropriate means such as, but not limited to, signage, fencing, traffic barricades, and lighting to warn, discourage, and prevent danger to adjacent workers and the public.
 - c. Unless otherwise indicated, install a minimum 6' 10-gauge chain link fence around all open excavations, retention ponds, and other areas of potential danger, and maintain them while such conditions exist. Increase measures as required by site conditions.

3.2 LAYOUT

- A. Surveyor: Secure the services of a licensed land surveyor, acceptable to the Architect/Engineer and Owner, to layout locations of building, parking areas, drive, walks, curbs, finish elevations and other work, including mechanical and electrical items that are to be installed on the project site.
- B. References: Establish and maintain lines, corners, elevations and general reference points. Verify dimensions indicated on Drawings. If conflicts exist, immediately notify the Architect/Engineer before continuing work.

3.3 EXCESS WATER CONTROL

- A. Excess moisture: If excess moisture is present in soil, do not resume operations until moisture content and density are reported to be satisfactory by the Geotechnical Engineer.

- B. Flooding: Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collecting in depressions.
- C. Softened subgrade: Where soil has been softened or eroded by flooding or placement during inclement weather, remove all damaged areas and recompact as specified for fill and compaction.
- D. Dewatering:
 - 1. Provide and maintain ample means and devices with which to promptly remove and dispose of all water from every source always entering the excavations or other parts of the work during construction.
 - 2. Dewater by means which will ensure dry excavations and the preservation of the final lines and grades at bottom of excavations, such as sump pumps, trenching, etc.
 - 3. Do not use extreme measures or durations to cause adverse effects to Project Site or adjoining properties.

3.4 CHEMICAL MODIFICATION

- A. General:
 - 1. Scarify and/or disc area to a depth of 12" prior to distributing modifiers.
 - 2. Utilize screw type, cyclone, or pressure manifold type distributors to apply modifier.
 - 3. Do not apply when wind conditions create potential hazards or transference of material to adjacent areas.
 - 4. Mix modifiers with rotary speed mixers or disc harrow and continue until a homogenous layer of the required thickness is obtained.
 - 5. Compaction:
 - a. Lime modified soils shall be compacted within 3 days.
 - b. Cement modified soils shall be compacted within 30 minutes.
 - 6. Observation and testing: Quantities of materials, placing, mixing, and compacting shall be, as recommended, observed and tested by the Geotechnical Engineer.

3.5 STOCKPILING

- A. General:
 - 1. See drawings for designated stockpiling areas. If Drawings do not designate specific areas, or areas shown are insufficient, contact Architect/Engineer for direction.
 - 2. Stockpile earth materials in manners that will prevent intermixing of different materials and intrusion of trash, debris and organic materials.
 - 3. Slope stockpiled materials to provide adequate surface drainage.
 - 4. Install and maintain erosion control measures. Refer to drawings and Division 31 Section "Erosion Control". At a minimum, silt fences shall be installed around all stockpiled areas. Seed areas which are to remain stockpiled for extended periods of time.
 - 5. Storage or stockpiling of materials on the subgrade is prohibited.

3.6 EXCAVATION

A. General:

1. Excavation shall conform to OSHA and all other applicable safety regulations.
2. Excavation shall conform to the dimensions and elevations indicated on the Drawings, except as specified herein.
3. Excavation shall extend sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and inspection.
4. Remove unsuitable material below indicated depths and replace it with suitable, compacted material or lean concrete, at the Architect/Engineer discretion.
5. Topsoil stripping: Strip topsoil to its depth from areas to be covered by building, by walks and by other work and where existing surface areas required grading to establish new elevations.
6. Subgrade: Unless otherwise indicated, excavate to following subgrades:
 - a. Slab-on-grade: Sub-grade at bottom of drainage fill or at bottom of existing topsoil, whichever is lower.
 - b. Drives and paving: Sub-grade at bottom of aggregate base.
 - c. Footing: Sub-grade at indicated bottom of footing.
 - d. Lawn area: Sub-grade 4" below indicated surface elevation.

3.7 TRENCHING

A. General:

1. All trenching shall conform to OSHA and all other applicable safety standards.
2. Verification:
 - a. Contractor shall verify all existing grades, inverts, utilities, obstacles and topographical conditions prior to any trenching, excavation or underground installations.
 - b. In the event existing conditions are such as to prevent installations in accordance with the Contract Documents, immediately notify the Architect/Engineer and await decision before continuing work.
 - c. Architect/Engineer decision will be final and binding upon the Contractor, and installations shall be in accordance with same.
3. Saw cut existing pavements to proper width for trenching.
4. Legally dispose materials unsuitable for trench backfilling off-site.

B. Width:

1. Trenches for piping shall be not less than 12" wide or more than 16" wider than the outside diameter of the pipe to be laid therein, and shall be excavated true-to-line, so that a clear space not less than 6" or more than 8" in width is provided on each side of the pipe.
2. For sewers, the maximum width of the trench specified shall apply to the width at and below the level at the top of the pipe. The width of the trench above that level may be made as wide as necessary for sheeting and bracing, and proper installation of the Work.

3. Trenches shall be open vertical construction.

C. Depth:

1. Trench as required to provide the elevations shown on the drawings.
2. Where elevations are not shown on the drawings, trench to sufficient depth to give a minimum of 36" of fill above the top of the pipes measured from the adjacent finish grade.
3. Where trench excavation is inadvertently carried below proper elevation, backfill with approved material and then compact to provide a firm and unyielding subgrade and/or foundation at no additional cost to the Owner.

D. Trench Bracing:

1. Properly support all trenches in strict accordance with all pertinent rules and regulations.
2. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind, whether on public or private property, will be fully protected from damage.
3. In the event of damage to such improvements, immediately make all repairs and replacements necessary at no additional cost to the Owner.
4. Arrange all bracing, sheeting, and shoring so as to not place stress on any portion of the completed Work until the general construction thereof has proceeded far enough to provide sufficient strength.
5. All shoring and sheeting required to perform and protect the excavation and as required for the safety of employees and abutting structures shall be performed. All workmen performing work in 48" or deeper trench or excavation shall be protected by use of a welded sheet steel "safety box."
6. Removal: Exercise care in the drawing and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.

E. Bedding:

1. Where pipes or conduits are to be installed, excavate below the proposed alignment of the pipe and backfill with clean sand to provide uniform support unless otherwise noted on the drawings.
2. Unless shown otherwise on Drawings, minimum bedding to be 4" below pipe.
3. Storm sewer pipes are to be bedded with stone.
4. Refer to drawings and details for further information and requirements.

F. Grading and Handling of Trenched Material:

1. During excavation, material shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins.
2. Control the temporary stockpiling of trenched material in a manner to prevent water from running into the excavations.
3. Do not obstruct the surface drainage but provide means whereby stormwater is diverted into existing gutters, surface drains or other temporary drains.
4. Any water accumulated in the trenches shall be removed by pumping or by other approved methods.

3.8 FILLING, BACKFILLING AND COMPACTING

- A. Prior to filling, backfilling and compacting, proof-roll and remediate subgrade per Part 3 Quality Assurance.
- B. Unless otherwise indicated, maximum lift thickness is 8" of un-compacted material.
- C. Moisture:
 - 1. Thoroughly mix each layer to assure uniformity of material.
 - 2. Supplement mixing with wetting or drying as required to obtain the moisture content required for the indicated percentages of compaction.
 - 3. All fill shall be placed so that the moisture content is within +/- 2% of the optimum moisture content according to ASTM D698.
 - 4. Do not use frozen materials in the fill or allow the fill to be placed upon frozen materials.
- D. Compaction:
 - 1. Compaction shall be accomplished by approved means and shall meet the following densities for various parts of the Work. See Part 2 for density requirements of individual soil materials.
 - 2. Compaction by flooding is not acceptable.
 - 3. In cut areas where pavement is planned, scarify the upper 12" of subgrade prior to compaction.
- E. Equipment:
 - 1. Tracked equipment shall not be used as compaction equipment.
 - 2. The static weight of compaction equipment utilized for the compaction of backfill materials near walls as defined in No.3 below shall not exceed 2,000 lbs. for non-vibratory equipment and 1,000 lbs. for vibratory equipment.
 - 3. All heavy equipment, including compaction equipment heavier than noted herein, shall not be allowed closer to walls than 3 feet plus the vertical distance from backfill surface to the bottom of the wall.

3.9 GRADING

- A. General:
 - 1. After filling and backfilling operations are complete, neatly and evenly grade areas to be seeded or sodded.
 - 2. Scarify subgrade to a depth of 6" and place minimum 4" topsoil (6" maximum).
 - 3. Grade to obtain the elevations indicated within a tolerance of plus or minus 0.1 foot.
 - 4. Slope finished subgrade surface to provide drainage away from building walls.
- B. Treatment After Completion of Grading:
 - 1. After grading is completed and inspected, permit no further excavation, filling, or grading except with the review of and the inspection by the Owner.

2. Use all necessary means to prevent the erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.10 QUALITY ASSURANCE

A. Coordination:

1. A representative from the Geotechnical Engineer shall be present to always observe and perform tests earthwork is in progress.
2. Contractor shall provide minimum 72 hour notice to Geotechnical Engineer before each operation requiring testing or inspection.

B. Testing:

1. To verify the adequacy of compaction, the Geotechnical Engineer shall perform field density tests.
2. A grid pattern shall be established with a maximum area of 1,000 square feet.
3. For each grid, provide a minimum of one test per each lift of compacted material.

C. Proof rolling:

1. Proof rolling shall be supervised by the Geotechnical Engineer.
2. Since standard test procedures are not available for proof rolling, the necessary scope and method of testing shall be determined by the Geotechnical Engineer, subject to review by the Architect/Engineer.
3. In areas covered by buildings and other site improvements, and other areas deemed necessary by the Geotechnical Engineer or Architect/Engineer, prepare and test subgrade as follows:
 - a. Using a loaded tri-axle dump truck or other approved method, the Contractor shall proof-roll the exposed subgrade under the observation of the Geotechnical Engineer.
 - b. Based on this observation, plus supplemental testing as required, the Geotechnical Engineer shall determine when and where soft, loose or other undesirable materials are to be removed and replaced.

D. Approval and Remediation:

1. When testing and proof rolling indicate proper compaction has been obtained, and after approval from Geotechnical Engineer has been given, continue fill and backfill work until the indicated elevation is achieved.
2. If required density has not obtained, the Contractor shall remove the defective material and repeat operations until the required density is obtained, and approval is given by the Geotechnical Engineer.
3. Cost of material removal, replacement, compaction and re-testing shall be the responsibility of the Contractor.

3.11 SURPLUS SOIL MATERIALS

- A. Unless otherwise indicated or directed by Owner, remove excess soil materials and legally dispose of off-site.

3.12 JOB COMPLETION

- A. Upon completion of the Work of this Section:
 - 1. Remove all trash and debris from earthwork operations.
 - 2. Remove surplus equipment and tools.
 - 3. Leave the site in a neat and orderly condition.
 - 4. Restore all adjacent areas disrupted by earthwork activities to their original condition.

END OF SECTION

SECTION 31 25 00 - EROSION CONTROL (PROJECTS DISTURBING LESS THAN 1 ACRE)

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Prevention of soil or sediment leaving project site.
2. Prevention of soil or sediment impacting on-site or off-site activities or conditions.
3. Dust control.

B. Related Sections:

1. Division 02 Section "Selective Site Demolition".
2. Division 31 Section "Site Clearing".
3. Division 31 Section "Earthwork".
4. Division 32 Section "Seeding".

I.2 SUBMITTALS

A. Product data for the following:

1. Silt fence.
2. Inlet filters.
3. Erosion control blanket and fasteners.

I.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. The standard for erosion/sediment control for this project is the Indiana Handbook for Erosion Control in Developing Areas, latest edition (Indiana Department of Natural Resources, Division of Soil Conservation). All erosion control work shall conform to this manual.

B. General Requirements:

1. Erosion/sediment control measures are to be installed prior to beginning any earth disturbing activities and maintained throughout construction.
2. The Contractor is responsible for ensuring all specified and necessary erosion/sediment control measures are installed, functioning and properly maintained.
3. Any fines or other costs incurred due to inadequate or improper installation, maintenance or performance of erosion/sediment control measures as identified by the self-monitoring

process and/or other agency having jurisdiction over erosion control shall be the sole responsibility of the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Silt Fence:

1. Woven or non-woven produced from 100% polypropylene, designed specifically to retain sediment and remain highly permeable to water.
2. Geotextile shall be attached to wood stakes with wood leathers and staples or nails.
3. Bottom 12 inches of fabric shall be left unsecured to allow for entrenchment.
4. Stakes: 2" x 2" x 36" hardwood sharpened to a point on one end, maximum 5' spacing.
5. Lath: 1/2" x 1 1/2" x 24" for attaching the fabric to the stakes.

B. Inlet Filters: Stream guard catch basin insert by Bowhead Environmental & Safety (800-909-3677), or Architect/Engineer approved equal.

C. Erosion Control Blanket:

1. Standard: unless otherwise indicated, North American Green S150 BN or approved equal.
2. General: woven, 100% biodegradable blanket, or approved equal.
3. Matrix: 100% straw fiber, 0.5 lbs/syd.
4. Netting: 100% biodegradable natural organic fiber.
5. Fasteners: 6" biodegradable plastic stakes.

D. Refer to Division 32 Sections "Seeding" and "Planting" for temporary and permanent ground cover requirements.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. General:

1. Prevent mud and dirt accumulation on all streets surrounding the project. Utilize stone tracking strips/construction entrances, street sweepers, spray trucks, power washers and other necessary and appropriate means as required. Roadways should be kept clear of accumulated sediment that is a result of runoff or tracking.
2. Dust control: Use all necessary and appropriate means, such as water sprinkling, calcium chloride (AASHTO M 144), vegetative cover, spray-on adhesives, as required to prevent dust from being a nuisance to the Owner, public or concurrent performance of work on the site.
3. Always keep the amount of disturbed area to a minimum.
4. Seed immediately after grading soil and install erosion control blanket where applicable.

5. Sequence installation of measures to ensure proper erosion control. See Drawings for basic sequencing requirements.
6. Temporarily seed all areas that cannot be final seeded within a period that will prevent soil erosion. For temporary seeding, utilize a fast-growing seed of oats, annual rye grass, wheat or rye depending on the time of year.
7. See Division 32 Section "Seeding" for seeding requirements.
8. The Contractor shall inform all Subcontractors of the requirements of the Construction Stormwater Pollution Prevention Plan (SWP3) and its maintenance provisions, so that erosion/sediment disruption may be prevented by all those working on site.
9. Un-vegetated areas that are likely to be left inactive for more than 15 days must be stabilized.
10. Proper storage and handling of materials, such as fuels or hazardous waste, and spill prevention and cleanup measures shall be implemented to minimize the potential for pollutants to contaminate surface or ground water or degrade soil quality. Notify Indiana Department of Environmental Management (IDEM) of any release.
11. Final stabilization shall be achieved when all land disturbing activities have been completed, and a perennial vegetative cover exists with at least a 70% density. Once this has been achieved, the Contractor shall notify the Owner and Architect/Engineer. The Contractor must still complete all maintenance and quality requirements as specified in Division 32 Sections "Seeding" and "Planting".

3.2 INSTALLATION

A. Silt Fence:

1. Install silt fences where indicated on Drawings and on other areas as required.
2. Follow all manufacturer guidelines for installation.
3. Dig a minimum 8" deep trench along proposed fence line to allow toe-in.
4. Install a fence with stakes on the downstream/slope side.
5. Backfill and compact both sides of trench and ensure fence is anchored sufficiently.

B. Erosion Control Blanket:

1. Install blankets where indicated on Drawings and on other areas as required.
2. Follow all manufacturer guidelines for installation, including minimum overlapping and anchoring/stapling spacing.
3. Tuck the uppermost edge of the upper blankets into a check slot (slit trench, minimum 6" deep), backfill with soil and tamp down.
4. See drawings for additional installation requirements.

C. Stone Tracking Area/Construction Entrance:

1. Install at all temporary entrances/exits for construction traffic and in other areas as needed to prevent soil materials from being deposited on streets, parking areas, etc.
2. Minimum thickness is 6" of #2 stone. Increase as necessary for field conditions. Install geotextile fabric underneath stone to improve stability if needed.
3. If entrance is indicated to be on existing pavement, provide measures to clean pavement regularly to prevent sediment from tracking off the construction site.
4. Minimum dimensions are shown on the plans. Increase as necessary for field conditions.

3.3 INSPECTION AND MAINTENANCE

A. General:

1. Inspect all erosion control measures periodically and after each storm event.
2. Repair and replace all measures as necessary to ensure proper soil erosion prevention.
3. Maintain temporary measures until vegetation has been adequately established and construction activities have been completed to a point where the potential for soil erosion has been sufficiently eliminated. The Contractor is responsible for maintaining temporary measures until such a point and then removing the measures, even if all other construction work is complete.
4. Implement erosion/sediment control modifications as directed by the Architect/Engineer.

B. Silt Fence:

1. Inspect periodically and after each storm event.
2. If fabric tears start to decompose, or in any way becomes ineffective, replace the affected portion immediately.
3. Remove deposited sediment when it reaches 1/3 of the height of the fence at its lowest point or when it is causing the fabric to bulge. Do not undermine the fence during cleanout.
4. After the contributing drainage area has been stabilized, remove the fence and sediment deposits, bring the disturbed area to grade and stabilize.

C. Erosion Control Blanket:

1. During vegetative establishment, inspect after each storm event for any erosion underneath the blanket.
2. If any area shows erosion, pull back that portion of the blanket, add soil, reseed, re-lay and re-anchor blanket.
3. After vegetative establishment, check the treated area periodically and repair as required.

D. Stone Tracking Area/Construction Entrance:

1. Inspect weekly and after storm events or heavy use.
2. Re-shape as needed for drainage and runoff control.
3. Top dress with clean stone as needed.
4. Immediately remove mud and sediment tracked or washed onto roads, parking lots, etc. by brushing or sweeping. Flushing is only to be used if the water is conveyed to a sediment trap or basin.

E. Inlet Filters:

1. Inspect each inlet periodically and after each storm event.
2. If fabric tears start to decompose, or in any way become ineffective, replace the affected portion immediately.
3. Remove deposited sediment often and do not allow it to build up and cause damage to the fabric or reduce the flow capacity of the inlet.
4. Remove inlet fabric after the contributing drainage area has been stabilized.

F. Seeding:

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1. Inspect temporary and permanent seeding periodically and after each storm event.
2. Repair damaged, bare or sparse areas by filling any gullies, re-fertilizing, over-seeding, re-seeding and re-mulching.
3. Install erosion control blanket over areas that do not hold.

G. Final Inspection and Acceptance:

1. Contractor shall notify the Owner in writing, 24 hours in advance that the project is ready for final inspection and acceptance. The following conditions must be met:
 - a. All land disturbing activities have been completed, and the entire site has been stabilized.
 - b. All temporary erosion and sediment control measures have been removed.

END OF SECTION

SECTION 32 12 16 - ASPHALT PAVING

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Asphalt paving as shown or implied by Contract Documents.
2. Asphalt paving is required because of trenching through or demolition of existing asphalt.

I.2 QUALITY ASSURANCE

A. All materials and work shall comply with the Indiana Department of Transportation Standard Specifications (INDOTSS), current edition.

B. Any work in public right-of-way, or other areas subject to the jurisdiction of anybody, shall be performed either to the requirements of that jurisdiction or to the requirements of this Specification, whichever is more stringent.

C. Testing and Inspection:

1. All testing and inspection shall be performed by an independent Geotechnical Engineering Consultant ("Geotechnical Engineer").
2. The Geotechnical Engineer is responsible for all testing, sampling and inspection.
3. The Geotechnical Engineer is responsible for approving all materials, installation and procedures.
4. The Contractor is responsible for providing these services.
5. The Contractor is responsible for all coordination and scheduling with the Geotechnical Engineer.

I.3 SUBMITTALS

A. Materials Certificates:

1. Materials certificates must be signed by material supplier and Contractor.
2. Certificates must be submitted for all asphalt paving items.
3. Certificates must state that each material item meets or exceeds specified requirements.

B. Job Mix Formulas:

1. Submit a job mix formula (JMF) for all asphalt paving work.

2. The JMF must state that the mix meets the requirements of INDOTSS Section 402 as specified herein.
3. The JMF must include the following, at a minimum:
 - a. Aggregate type, source and gradation.
 - b. Type and percent of binder (actual and extracted).
 - c. Voids in mineral aggregate (VMA).
 - d. Voids filled with asphalt (VFA).
 - e. Percent of air voids.
 - f. Density.
 - g. Amount of recycled materials in intermediate course, if applicable.

C. Other:

1. Testing and inspection reports.

PART 2 - PRODUCTS

2.1 PAVING

A. Aggregates:

1. Fine aggregates: INDOTSS Section 904.02
2. Coarse aggregates: INDOTSS Section 904.03
3. All crushed stones for the aggregate base shall be per the INDOTSS gradations and CAPP specifications.
4. Commercial grade aggregates are not acceptable.

B. Asphalt Materials:

1. General: INDOTSS Section 402.
2. Binder: Performance Graded Asphalt Binder, INDOTSS 902.01 (a).
3. Prime coat: Asphalt Emulsion, AE-PMP, INDOTSS 902.01 (b).
4. Tack coat: Asphalt Emulsion, AE-PMT, INDOTSS 902.01 (b).
5. Recycled asphalt materials:
 - a. Do not exceed the maximum allowable amount per INDOTSS 401.06.

C. Mixtures:

1. Percent of aggregates passing sieves.

Sieve Size	Surface	Intermediate
19.0 mm (3/4 in.)	100	100
12.5 mm (1/2 in.)	100	70-92
9.5 mm (3/8 in.)	96-100	50-75
4.75 mm (No. 4)	75±5	40±5
2.36 mm (No. 8)	36-66	18-45
1.18 mm (No. 16)	19-50	10-36
600 mm (No. 30)	10-38	6-26

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300 µm (No. 50)	5-26	2-18
150 µm (No. 100)	2-17	0-11
75 µm (No. 200)	0-5	0-4
Percent of Bitumen	5.7 – 7.2	4.1 – 5.2
Percent Air Voids	4.0	4.0

2. The contractor is responsible for adjusting the mix, if required for proper placement and performance. Any such modifications shall be approved by the Architect/Engineer.
- D. Unless otherwise indicated or required by jurisdictions having authority, a prime coat is to be used at the discretion of the Contractor, as necessary and appropriate to ensure proper protection and placement of paving.

PART 3 - EXECUTION

3.1 GENERAL

A. Protection:

1. Provide all necessary barricades and markers to keep vehicular traffic off freshly placed paving until the pavement has cooled and hardened for at least twelve hours.
2. During paving operations, exercise care not to chip, spall, scar or otherwise damage curbs, walks, buildings and other work. Any such damage shall be repaired to the Owner's satisfaction by the Contractor at the Contractor's expense.

B. Job Conditions:

1. Weather limitations:

- a. Apply prime and tack coats when ambient temperature is above 50 degrees F, (10 degrees C), and when temperature has not been below 35 degrees F, (1 degree C), for 12 hours immediately prior to application. Do not apply when the base is wet or contains an excess of moisture.
 - b. Place intermediate course when air temperature is above 30 degrees F, (-1 degree C), and rising.
 - c. Place surface course when air temperature is above 40 degrees F, (4 degrees C), and when intermediate course is dry.
2. Asphalt temperature: The paving mixture shall be placed and compacted at a temperature between 250°F (121°C) and 300°F (149°C).

3.2 PAVING

A. Grading and Drainage:

- I. Ensure positive and adequate grading for all work. Notify Architect/Engineer of any concerns or conflicts prior to installation.
- B. Preparation:
 1. Immediately prior to placing the base course, proof-roll the sub-base with a pneumatic tire roller.
 2. Remove and replace all areas of failures, irregularities and roller marks in the sub-base so that it meets the compaction requirements of Division 31 Section "Earthwork".
- C. Placement:
 - I. Aggregate base course:
 - a. Place base course only on solid, dry and unfrozen subsurface.
 - b. Unless specified otherwise on the Drawings, the aggregate base shall consist of the following minimum requirements: a 4" layer of compacted No. 53 crushed stone on top of a 4" layer of compacted No. 2 crushed stone, for a minimum overall compacted thickness of 8".
 2. Intermediate course:
 - a. Immediately prior to the placing of the intermediate course, proof roll the aggregate base course by making a minimum of two passes over the entire areas with a pneumatic tire roller. Remove and replace all areas of failures, irregularities and roller marks in the base course.
 - b. Place intermediate courses only on clean, solid, dry and unfrozen sub-course.
 - c. Spread each course concurrently, within practical limits, using mechanical spreaders.
 - d. Intermediate course shall have minimum 3" compacted thickness, unless specified otherwise on the Drawings.
 3. Surface course:
 - a. Place surface course only on clean, solid, dry and unfrozen sub-course.
 - b. Apply tack coat to the underlying surface as necessary to ensure proper placement.
 - c. Spread each course concurrently, within practical limits, using mechanical spreaders.
 - d. Surface course shall have minimum 1 1/2" compacted thickness, unless specified otherwise on the Drawings.
 4. Abutting existing asphalt pavement:
 - a. Saw cut the existing pavement straight and true.
 - b. Ensure new pavement elevation matches existing.
 - c. Ensure joints are clean and tight, with no gap or traveling.
 - d. Refer to Drawings for abutment detail.
- D. Compaction:

- I. Aggregate base course:
 - a. Prior to compacting, remove any foreign materials that have become incorporated into the base course.
 - b. Thoroughly compact base course to the proper elevations and density.
2. Intermediate and surface courses:
 - a. Prior compacting, remove any foreign materials that have become incorporated into the paving courses.
 - b. Follow the spreading processes immediately with rollers of sufficient size to compact the paving courses to their proper densities and elevations.
 - c. Ensure no low spots exist which might retain water.
 - d. Perform additional rolling as required to produce a well compacted, crack-free, fissure-free surface of uniform texture, without evidence of tool or machine marks.
 - e. Do not roll over the unprotected edge of a spread.

3.3 PATCHING

- A. Saw cut around areas to be patched or repaired.
- B. Remove existing pavement down to sound base, excavating with vertical faces.
- C. Replace with a full-deep patch, making neat, even and crisp joint with adjacent areas.
- D. Patched areas shall match adjacent areas in texture and grade.

3.4 FIELD QUALITY CONTROL

- A. Coordination:
 1. The Geotechnical Engineer shall be present to always observe and perform tests paving work is in progress.
 2. Contractor shall provide a minimum of 72-hour notice to the Geotechnical Engineer before each operation requiring testing or inspection.
- B. Testing:
 1. Geotechnical Engineer shall take one sample per lift of asphalt concrete for each 5,000 square feet of pavement area, with a minimum of two samples per lift of asphalt concrete each day before paving operation. The following laboratory tests shall be performed:
 - a. Aggregate gradation.
 - b. Binder content.
 - c. Density.
 - d. Percent air voids.

2. Geotechnical Engineer shall test in-place compacted asphalt for density with nuclear penetrometer (backscatter, no drilling of pavement). Geotechnical Engineer shall take one reading per lift of asphalt concrete for each 1,000 square feet of pavement area, with a minimum of two readings per lift of asphalt concrete each day. The in-place density shall be a minimum of 94% of the maximum theoretical density per the Job Mix Formula.

C. Thickness:

1. The in-place compacted thickness will not be acceptable if it exceeds the following allowable variation from the required thickness:
 - a. Base course: $\frac{1}{2}$ ".
 - b. Intermediate course: $\frac{1}{4}$ ".
 - c. Surface course: $\frac{1}{4}$ ".

D. Surface Smoothness:

1. The finished surface will not be acceptable if it exceeds the following tolerances, using 10' straightedge applied parallel with and at right angles to centerline of paved area:
 - a. Base course: $\frac{1}{4}$ ".
 - b. Intermediate course: $\frac{1}{8}$ ".
 - c. Surface course: $\frac{1}{8}$ ".
 - d. Finished grade shall be within $\frac{1}{2}$ " of grade specified on the drawings.

E. Unsatisfactory Pavement:

1. The contractor is responsible for removing and replacing pavements that do not meet the Specifications herein, as well as any pavement deemed unacceptable by Architect/Engineer, Geotechnical Engineer or Owner.
2. The Contractor is responsible for the cost of any re-testing due to unsatisfactory pavement replacement.

3.5 COMPLETION OF WORK

A. At the completion of paving operations, the Contractor shall perform the following:

1. Remove all protective barricades and markers.
2. Clean paving materials from all structures, curbs, walks, mechanical and electrical items, and other surfaces to which the paving is incidental and not intended.

END OF SECTION

SECTION 32 13 00 - SITE CONCRETE

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete outside of the building for site improvements including, but not limited to, the following:
 - a. Curbing, gutters, walks and pavement.
 - b. Equipment pads, light pole bases, utility trench protection and bollard anchorage.

I.2 QUALITY ASSURANCE

- A. Any work in public right-of-way or other areas subject to the jurisdiction of anybody shall be performed either to the requirements of that jurisdiction or to the requirements of this Specification, whichever is more stringent.
- B. Qualifications of Workers:
1. Provide at least one person who shall always be present during the execution of this portion of the work.
 2. This person should be thoroughly familiar with the type of materials being installed and the best methods for their installation.
 3. This person shall direct all work performed under this Section.
- C. Manufacturer: manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.
- D. Codes and Standards:
1. In addition to complying with all pertinent codes and regulations, comply with all pertinent requirements of the following American Concrete Institute Publications:
 - a. "Building Code Requirements for Reinforced Concrete" ACI 318-99.
 - b. "Recommended Practice for Cold Weather Concreting" ACI 306 R-88.
 - c. "Recommended Practice for Hot Weather Concreting" ACI 305 R-91.
 - d. "Recommended Practice for Evaluation of Strength Test Result for Concrete" ACI 214-77.
 - e. "Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete" ACI 211.1-98.
 2. Where provisions of pertinent codes and standards conflict with this Section, the more stringent provisions shall govern.

E. Testing and Inspection:

1. All testing and inspection shall be performed by an independent Geotechnical Engineering Consultant ("Geotechnical Engineer").
2. The Geotechnical Engineer is responsible for all testing, sampling and inspection.
3. The Geotechnical Engineer is responsible for approving all materials, installation and procedures.
4. The Contractor is responsible for providing these services.
5. The Contractor is responsible for all coordination and scheduling with the Geotechnical Engineer.

I.3 SUBMITTALS

- A. Mix Designs.
- B. Testing and inspection reports.
- C. Chloride ion tests or total chloride tests (with generally accepted method to relate total chloride to chloride ion) to show compliance with maximum ion concentrations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:

1. Cement: ASTM C150, Type I or III.
2. Fine aggregate: ASTM C33.
3. Coarse aggregate: ASTM C33.
 - a. Crushed stone shall be used for exterior concrete, unless otherwise noted.
 - b. Maximum aggregate size is 3/4 of the minimum clear spacing (per code) between reinforcing bars or between bars and forms.
4. Water: Clean, fresh, potable.
5. Air-entraining admixture: ASTM C260.
6. Fly ash: ASTM C618.
7. Fiber mesh:
 - a. Fiber mesh shall be polypropylene fibrillated, and mix shall contain a minimum of 1.5 lbs. of fiber per cubic yard of concrete, unless otherwise prescribed by manufacturer and approved by Architect/Engineer.
 - b. Fiber shall be mixed at batch plant; field mixing is not acceptable.
8. Sealer/curing compound:
 - a. ASTM C309, Type I, clear.
 - b. Compatible with texture of surfaces.

B. Mix Design:

1. Strength: 4000 psi, ready mixed in accordance with ASTM C94.
2. Slump: 4" +/- 1".
3. Minimum cement content: 517 pounds per cubic yard (adjust for air entrainment)
4. Fly ash shall not replace more than 20% of the cement.
5. Maximum water/cement ratio: 0.40.
6. Air entrainment: 6%. The percentage of air content shall be determined in accordance with the admixture manufacturer's recommendations based on aggregate size and moderate level of exposure.
7. White concrete must have a 3-year aged minimum SR value of 0.28, or initial SR value of at least 33.

C. Other Requirements:

1. Proportions of materials for concrete shall be established in accordance with Section 5.2 of ACI 318 (Latest edition).
2. Follow ACI 211 and ACI 301 to determine the water-cement ratios.
3. Concrete shall not exceed maximum chloride ion content for corrosion protection as defined in ACI 318 Table 4.4.1.
4. Do not use calcium chloride or admixtures containing soluble chlorides.
5. Do not use re-tempered concrete or concrete that has been contaminated by foreign materials.
6. All exterior concrete shall be air entrained.
7. Unless otherwise indicated, all reinforcing for concrete pavement shall be epoxy coated.

D. Isolation Joints: Unless specified otherwise on Drawings, use the following:

1. Cork isolation joints with sealant:
 - a. Joint material: AASHTO M213; 1/2 inch thick.
 - b. Joint sealer: AASHTO M173; polyurethane with color matching adjacent concrete
 - c. Application: Use cork isolation joints with sealant for isolation joints for sidewalks, drop-offs, decorative concrete pavement areas, areas adjacent to buildings, structures, and columns.
2. Asphalt saturated cellulosic fiber:
 - a. Joint material: AASHTO M213; 1/2 inch thick.
 - b. Do not place sealant on asphalt saturated cellulosic fiber isolation joints.
 - c. Application: Use this type of isolation joint for items such as curbs and walks, which are in areas not adjacent to buildings, structures and columns, etc. Do not use in areas of colored concrete.
3. Contact Architect/Engineer if further direction is needed for proper application in specific areas.

2.2 STEEL REINFORCING

A. Reinforcing Bars:

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1. Reinforcing bars and dowels: ASTM A615, Grade 60.
2. Reinforcing to be welded: ASTM A615, Grade 40.
3. Epoxy coated bars and dowels: ASTM A884, Grade 60.

B. Welded Wire Fabric:

1. ASTM A185 6"x6" xW1.4xW1.4, unless otherwise indicated.
2. Provide in flat sheets, not rolled form.

C. Other Embedded Items: Provide standard manufactured products as approved by the Architect/Engineer.

D. Bar Supports:

1. Conform to the requirements of the "Manual of Standard Practice", published by the Concrete Reinforcing Steel Institute.
2. Accessories shall be plastic protected Class "C" for all concrete exposed in the finished structure, except as specified below.
3. Accessories shall be Class "A", bright basic, for unexposed concrete.
4. Utilize Call "E," stainless steel bar supports, for exterior concrete to be finished by sand blasting.
5. Do not use continuous highchairs. Use individual highchairs laced with bottom cross bars plus #5 support bars. (Minimum of 2 rows of support for all reinforcing).
6. Supports must be capable of supporting construction loads without failing. Contractor to furnish additional supports at no cost to the Owner if in the Architect/Engineer estimation the supports are not adequate.

2.3 FORMWORK

A. Form Lumber:

1. All form lumber in contact with exposed concrete shall be new or of sufficient quality to ensure an unblemished texture.
2. All form lumber shall be plywood, board lumber, hardwood or other material of grade or quality to best suit each particular usage.

B. Fiber Forms:

1. Fiber forms may be utilized to construct round columns/piers.
2. Seamless forms must be used for concrete exposed in the finished structure.
3. Standard seamed tubes are permissible for non-exposed concrete.

C. Form Release Agent:

1. Standards:
 - a. The release agent shall be similar to Symons Manufacturing Company Magic Kote.
 - b. Grace Construction Products Formshield Chemical Release Agent.

D. Bracing/Shoring/Studs:

- I. Such supports should be selected for the economy consistent with safety requirements and the quality required in the finished work. The Contractor is responsible for the design, illustration, safety and serviceability of all formworks.
- E. Other Materials: All other materials, not specifically described, but required for proper completion of concrete formwork, shall be selected by the Contractor subject to advance acceptance by the Architect/Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. Job Conditions:

- I. Extreme temperature conditions:
 - a. When extreme hot or cold weather conditions occur, or are expected to occur, which might detrimentally affect concrete, employ handling and placing techniques to guard against such effects.
 - b. Comply with the recommendations of American Concrete Institute for hot and cold weather concreting. ACI Publications ACI 306 and ACI 305.
2. Inclement weather: Unless adequate protection is provided, do not place exterior concrete during rain, sleet or snow.

B. Preparation and Verification:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly begin.
2. Verify all items to be embedded in concrete are in place.
3. Verify concrete may be placed on the lines and elevations indicated on the Drawings, with all required clearances for reinforcement.
4. Verify forms may be constructed in accordance with all pertinent codes and regulations, the referenced standards and the original design.
5. Remove all dirt, oil, paint, loose rust and other foreign materials from the concrete reinforcement prior to placement.
6. In the event of discrepancy, contact Architect/Engineer immediately and do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
7. Verify approval of mock-ups by Owner and Architect/Engineer before beginning work.

C. Other: Unless otherwise indicated, all exterior concrete shall be placed on a compacted aggregate fill per the following:

1. Minimum depth equal to the concrete thickness for pavement, walks and other slabs on grade.
2. Minimum 6" depth of fill for curbing and other support bases.

3.2 FORMWORK

A. Protection:

1. Use all necessary and appropriate means to protect formwork materials before, during and after installation.
2. Protect the installed work and materials of all other trades.
3. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to Owner or other trades.

B. General:

1. Forms shall have sufficient strength and be sufficiently tight to prevent leakage of mortar.
2. The design and engineering of the formwork shall be the responsibility of the Contractor.
3. Refer to this Section for construction joint requirements.
4. Tolerances: Construct all forms straight, true, plumb and square within the tolerances recommended by ACI 347.
5. Embedded items: Set all required steel frames, angles, grilles, bolts, reglets, inserts, pipe, conduit and other such items required to be anchored in the concrete before the concrete is placed.
6. Wetting: Keep forms sufficiently wetted to prevent joints opening before concrete is placed, except as recommended in ACI 306 R-78, "Recommended Practice for Cold Weather Concreting."

C. Layout:

1. Form all required cast-in-place concrete to the shapes, sizes, lines and dimensions indicated on the Drawings.
2. Exercise particular care in the layout of forms to ensure the proper finish structure, size and shape.
3. Make proper provisions for all openings, offsets, recesses, anchorage, blocking and other features of the Work as shown or required.
4. Carefully examine the Contract Documents and consult with other trades as required to ensure proper provisions for openings, reglets, chases, and other items in the forms.

D. Bracing and Shoring:

1. Properly brace and tie the forms together to maintain position and shape and to ensure safety to personnel.
2. Construct all bracing, supporting members, and centering of ample size and strength to safely carry, without excessive deflection, all dead and live loads to which they may be subjected.
3. Properly space the forms apart and securely tie them together, using metal spreader ties that give positive tying and accurate spreading.
4. All shoring shall extend to adequate foundations.
5. The Contractor is responsible for both the proper design and installation of all bracing and shoring, to properly ensure the safety and serviceability of the structure.

E. Plywood Forms:

1. Assembly: Nail the plywood panels directly to studs and apply in a manner to minimize the number of joints.
 2. Joints: Make all panel joints tight but joints with all edges true and square.
- F. Reuse of forms:
1. Reuse of forms shall in no way delay or change the schedule for placement of concrete from the schedule obtainable if all forms were new.
 2. Reuse of forms shall in no way impart less structural stability to the forms, nor less acceptable appearance to finished concrete.
- G. Cleaning:
1. Before concrete is placed the forms shall be cleaned of all debris, ice, snow, frost, and standing water.
 2. Remove all loose earth materials from the surfaces of earth forms.
- H. Removal of Forms:
1. Forms should be removed in such a manner to ensure complete safety of the structure.
 2. Formwork for columns, walls, and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations with the following minimums:
 - a. Formwork for walls and columns shall remain in place a minimum of two (2) days during which the temperature of the air surrounding the concrete must be above 50° F.
 - b. This minimum time period represents a cumulative number of days or fractions thereof.
 - c. Such formwork for concrete placed during cold weather with surrounding air temperatures 50° F shall remain in place one day after the artificial heating and/or freeze protection is discontinued/removed.
 3. Forms and false work:
 - a. Any supporting vertical loads shall remain in place until the members have acquired sufficient strength to safely support their weight and any superimposed loads.
 - b. Such forming shall remain in place until the concrete has attained its specified 28-day strength as indicated by the test cylinders unless re-shores are installed in sufficient quantities to transmit the loads to adequate foundations without stressing the particularly cured structure.
 - c. The requirements of ACI 305 and 306 must also be met before forms may be removed.
 - d. Removal of forms and false work is the responsibility of the Contractor, and the Contractor shall bear full responsibility for this operation.
 - e. Concrete damaged by too early removal of forms or false work shall be repaired or replaced as directed by the Architect/Engineer.
 4. Concrete exposed by form removal during the curing period shall be cured by one of the methods specified in this Section.

5. Curing compounds are not permitted in certain locations. In these cases, curing is to be by an alternate method. Refer alternate methods in this Section.
6. In no case shall the superimposed load or relatively new concrete exceed 50 pounds per square foot unless proper shoring to suitable foundations is installed as required by the Architect/Engineer.
7. Use all necessary and appropriate means to protect workman, public, the installed work and materials of other trades, and the complete safety of the structure.
8. Cut nails and similar fasteners off flush and leave all surfaces smooth and clean.

3.3 REINFORCEMENT

A. Protection:

1. Use all necessary and appropriate means necessary to protect concrete reinforcement before, during and after installation and to protect the installed work and materials of all other trades.
2. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
3. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Owner.

B. Placing:

1. Reinforcing bars:

- a. Positively secure reinforcing bar supports and tie or otherwise anchor bars to prevent displacement by construction loads or by the placing of concrete.
- b. Splice bars with a minimum lap of 40 bar diameters, unless otherwise indicated.
- c. Use mechanical splicers/couplers where quantity of reinforcement restricts placement of concrete if lapped splices are utilized.
- d. Splice bars only at locations indicated on the Contract Documents and shop drawings.
- e. Both shop and field bending shall be accomplished without heating the bars.
- f. Minor placing adjustments can be made to avoid interference with other reinforcement and/or embedded devices. The final arrangement, however, is subject to review and acceptance of the Architect/Engineer.
- g. Immediately notify the Architect/Engineer if reinforcing cannot be installed as shown on drawings. No cutting of reinforcing shall occur unless the Architect/Engineer has reviewed and approved such cuts.

2. Embedded devices:

- a. Set hangers, anchor bolts, inserts, and other embedded devices accurately in place.
- b. Make sure all such devices are installed so that the work to be attached thereto will be properly received.
- c. Keep devices straight and true-to-line.

3. Welded wire fabric:

- a. Splice by lapping each section at least two meshes wide plus one wire with the adjacent section, but not less than 8”.
- b. Extend fabric into all openings, doorways, and the like, unless otherwise indicated.

C. Final Cleaning:

1. Prior to placing concrete, remove all loose mill and rust scale, oil, mud, ice, and other foreign coatings which destroy and/or reduce bond between the reinforcement and concrete.
2. Use wire brushing and/or other suitable methods to complete cleaning operations.

3.4 CONCRETE PLACEMENT

A. Preparation:

1. Remove all wood scraps, ice, snow, frost, standing water and debris from the area in which concrete will be placed.
2. Thoroughly wet the surface of excavations (except in freezing weather), coat forms with release agent and remove all standing water.

B. Method:

1. Convey concrete from mixer to place of final deposit by methods that will prevent separation and loss of materials.
2. For chuting, pumping and pneumatically conveying concrete, use only equipment of such size and design as to ensure a practically continuous flow of concrete at the delivery end without loss or separation of materials.
3. Deposit concrete as nearly as possible in its final position to avoid segregation due to re-handling and flowing.
4. Use screed poles or similar devices to ensure that all slabs are cast at the proper elevations and that specified tolerances are maintained.

C. Rate of Placement:

1. Place concrete at such a rate that concrete is always plastic and flows readily between reinforcement.
2. Once placing is started, carry it on as a continuous operation until the placement of the panel or section is complete.
3. Do not pour a greater area at one time than can be properly finished. This is particularly important during hot or dry weather.

D. Consolidation:

1. Thoroughly consolidate all concrete by mechanical vibration, hand, and other suitable means during placement, working it around all embedded fixtures and into corners of forms.
2. Do not over-consolidate when using mechanical vibration to cause separation of the aggregate.

3.5 JOINTS

- A. Unless otherwise shown on Drawings, joints shall meet the following minimum requirements. If questions or concerns exist, contact Architect/Engineer for direction.
- B. Isolation Joints:
 - 1. General:
 - a. Tool concrete on both sides of joint (1/4" radius).
 - b. Install joint material to full depth of concrete.
 - c. See Part 2 Products for type of joint material to be used.
 - d. Install sufficient smooth doweling reinforcing to prevent differential movement in curbing, walks and pavement.
 - e. Do not dowel into such items as columns and exterior building walls/foundations, unless specified on drawings. Refer to structural drawings also.
 - f. Unless otherwise indicated, install isolation joints per the following minimum requirements.
 - 2. Curbing:
 - a. Provide each side of inlet castings.
 - b. Provide at all tangent points and changes in direction.
 - 3. Walks:
 - a. For walks 6 feet in width and less, provide at intervals not exceeding 25 feet.
 - b. For larger walks and plaza areas, provide at intervals not exceeding 20 feet in any direction.
 - 4. Pavement: Provide at intervals not exceeding 20 feet in any direction.
 - 5. Retaining walls: Provide at intervals not exceeding 40 feet per linear length of wall.
 - 6. Other:
 - a. Provide accessible ramps, buildings, columns, bollards, castings, drains and other locations as necessary to prevent excess cracking or displacement.
 - b. Contact Architect/Engineer if any areas of question or concern are encountered.
- C. Control Joints:
 - 1. General:
 - a. Control joint depth shall be minimum 1/4 of the slab thickness.
 - b. Continue one half of reinforcing through joint.
 - c. Install joints by tooling or saw cutting as described below, unless otherwise indicated.
 - d. Construction joints may be used where appropriate.
 - 2. Curbing: Saw cut at intervals not exceeding 10 feet.
 - 3. Walks: Tool joints at intervals not-to-exceed 5 feet in any direction.

4. Pavement: Saw cut at intervals not exceeding 18x pavement thickness feet in any direction.
5. Retaining walls: Provide at intervals not exceeding 20 feet per linear length of wall.
6. Other:
 - a. Provide accessible ramps, columns, bollards, castings, drains and other locations as necessary to prevent excess cracking.
 - b. Contact Architect/Engineer if any areas of question or concern are encountered.

D. Construction Joints:

1. Joints shall be made with properly constructed bulkheads and formed keyways.
2. Extend reinforcing through construction joints, unless otherwise indicated.
3. The Contractor shall consult with the Architect/Engineer before starting concrete work to establish a satisfactory placing schedule and to confirm joint locations.
4. Retaining walls: Provide at intervals not exceeding 80 feet per linear length of wall.

E. Tooled Joints and Scoring:

1. Make straight, clean and non-ragged.
2. Tool or score concrete on both sides of joint (1/4" radius).
3. Provide windowpane joint finishes unless otherwise indicated.

F. Bond Break: 15 per 100 square foot building paper.

3.6 FINISHING

- A. Unless otherwise indicated, provide a light-broom finish on all exterior slabs, walks and stairs.
- B. Provide a dry-rub finish for all exposed concrete walls, curbs or edge surfaces.

3.7 CURING

A. Formed Surfaces:

1. Cure formed surfaces by either of the following methods:
 - a. Leave forms in place until the cumulative number of days or fractions thereof, not necessarily consecutive, has totaled seven days during which the temperature of the air in contact with the concrete is 50°F or above.
 - b. Remove forms at an earlier time but apply curing compound to concrete surfaces.
 - c. Apply compound in accordance with manufacturer's recommendations.
2. If curing compound is not used and the forms are stripped prior to 7 days curing, the following methods are approved:
 - a. Ponding or continuous sprinkling.
 - b. Continuously wet mats.
 - c. Sand kept continuously wet.

3.8 PATCHING

- A. Patch existing concrete to receive new finish in a manner so that existing and patched surfaces are smooth and continuous and have a uniform appearance.

3.9 QUALITY ASSURANCE

A. Coordination:

- 1. A representative from the Geotechnical Engineer shall be present to always observe and perform tests. The site concrete work is in progress.
- 2. The contractor shall provide a minimum of 72 hours' notice to the Geotechnical Engineer before each operation requiring testing or inspection.

B. Inspection:

- 1. Immediately after forms and curing membranes have been removed, inspect all concrete surfaces and patch all pour joints, voids, rock pockets, form tie holds and other imperfections before the concrete is thoroughly dry.
- 2. If the defects are serious or affect the strength of the structure, or if patching does not satisfactorily restore the quality and appearance of the surface, the concrete shall be removed and replaced complete, at no additional cost to the Owner.

C. Testing: The Geotechnical Engineer shall perform the following:

1. Compression tests:

- a. Secure three standard cylinders from each pour of concrete, in accordance with ASTM C31, and cure under standard moisture and temperature conditions.
- b. Test in accordance with ASTM C39.
- c. Test one cylinder at 7 days and two cylinders at 28 days.
- d. Submit duplicate test reports of results from testing to Architect/Engineer.
- e. Take steps immediately to evaluate unsatisfactory test results.
- f. In the event of unsatisfactory test results, an investigation as outlined in Section 5.6.5 of ACI 318-99 shall be employed.

2. Slump and air entrainment:

- a. Perform slump tests in accordance with ASTM C143.
- b. Determine the air content of concrete in accordance with ASTM standards.
- c. Submit results of slump tests and air content on each compression test report.

- 3. Should additional testing be required because of unsatisfactory test results, the Contractor is responsible for the costs incurred for correcting any deficiencies and the cost of additional testing.

END OF SECTION

SECTION 32 92 19 - SEEDING

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Furnish and install all labor, material, and equipment necessary for seeding all areas as indicated or implied by the Contract Documents.

B. Related Sections:

1. Division 31 Section "Earthwork".

I.2 QUALITY ASSURANCE:

A. Installer Qualifications:

1. Engage an experienced installer who has completed seeding work similar in material, design, and extent to that indicated for this project and with a record of successful lawn establishment.
2. All work described in this Section is to be done by an installer specializing in such work within the five (5) years of documented experience in similar work.

B. Refer to Division 31 Section "Earthwork" for top-soil requirements and amendment recommendations to bring soil to optimal condition for growing lawn grass seed.

C. Applicable Publications:

1. The publications of the following institutes, associations, societies, and agencies are referred to in this Section.
2. American Joint Committee on Horticulture Nomenclature Standard: Standardized Plant Names, 1942 Edition and Additions.

D. Requirements of Regulatory Agencies:

1. Certificates of inspection: All shipments of seed shall be properly inspected at the nursery or at the growing site by the authorized Federal and State authorities. All necessary inspection certificates shall accompany the invoice for each shipment or order of stock, as may be required by law for the necessary transportation. Certificates shall be filed with the Architect/Engineer, prior to acceptance of the materials.

I.3 SUBMITTALS

ICI Warehouse Expansion Project

- A. Certification of grass seed from seed vendor for each grass seed mixture stating the botanical name, common name, and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for lawn seeding identifying source including name and telephone number of supplier.
- B. Topsoil analysis: Refer to Division 31 Section "Earthwork".
- C. One copy of Certificates of Inspection of Regulatory Agencies as specified herein.
- D. Qualification data for firms and people specified in the "Quality Assurance" articles demonstrate their capabilities and experience. Include list of completed projects with project names and addresses; names and address of Owners and other information specified.
- E. For hydroseeding applications only: submit product data sheets for tackifiers and any other slurry ingredients.

I.4 SCHEDULING

- A. Seasonal Requirements:
 - 1. Perform the seeding work between 1 March and 15 May or between 15 August and 15 October, or both, unless otherwise approved by the Architect/Engineer; and at such time that the seeding work will not be damaged by freezing temperatures, rain or high winds.
- B. Scheduling:
 - 1. Seeding operations shall not commence in any area until other trades no longer need machine access to these areas.
 - 2. Begin installation of seeding after preceding related work is accepted.

I.5 PRODUCT HANDLING

- A. Storage:
 - 1. Store in a dry, secure location off the ground, free from physical abuse.
 - 2. Protect from adverse weather conditions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: Seed of grass species as follows, with not less than 98 percent pure seed, not less than 85 percent germination, and not more than 0.3 percent weed seed:

- I. Permanent seed: Full sun or partial shade:
 - a. 90% Hybrid Bluegrass blend – a minimum of 3 varieties evenly blended, such as Midnight II, Rugby II, Nuglade, or as approved by Architect/Engineer.
 - b. 10% Perennial Rye Grass.
2. Permanent seed: Full shade:
 - a. 20% Hybrid Bluegrass.
 - b. 40% Creeping Red Fescue.
 - c. 20% Hard Fescue.
 - d. 20% Chewings Fescue.
3. Temporary seed:
 - a. 100% Annual Rye Grass.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602 agricultural limestone containing a minimum 80 percent calcium carbonate equivalent as follows:
 - I. Class: Class T with a minimum 99 percent passing through No 8 sieve and a minimum 75 percent passing through No 60 sieve.
- B. Aluminum Sulfate: Commercial grade, unadulterated
- C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate
- D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.3 ORGANIC SOIL AMENDMENTS

- A. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 – 4.8.
- B. Compost: Well-composted, stable and weed free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1 inch sieve; not exceeding 0.5 percent inert contaminants and free of substances toxic to humans and plantings.

2.4 MULCHES

- A. Straw Mulch: Provide air dry, clean mildew and seed free, salt hay or thrashed straw of wheat, rye, oats, or barley.
- B. Non-Asphaltic Tackifier: Colloidal tackifier recommended by fiber mulch manufacturer for slurry application; nontoxic and free of plant material or germination inhibitors.

- C. Asphalt Emulsion: ASTM D977, Grade SS-I nontoxic and free of plant-growth or germination inhibitors.

2.5 FERTILIZER

- A. Bone Meal: Commercial, raw or steamed, finely ground; a minimum 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial grade complete fertilizer of neutral character, consisting of fast and slow-release nitrogen 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - I. Composition: 12 percent of actual nitrogen, 12 percent phosphorous, and 12 percent potassium by weight.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water insoluble nitrogen, phosphorous, and potassium in the following composition:
 - I. Composition: 20 percent nitrogen, 10 percent phosphorous and 10 percent potassium by weight.

2.6 WATER

- A. Potable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Inspection:
 - 1. Verify soil preparation and related preceding work have been completed.
 - 2. Do not start work until other trades no longer need machine access to these areas.
 - 3. Do not start work until conditions are satisfactory.
- B. Preparation:
 - 1. Protect structures, utilities, sidewalks, pavements and other facilities, trees, shrubs and plantings from damage caused by planting operations.
 - 2. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties or walkways.

3.2 LAWN PREPARATION

- A. Limit lawn preparation to areas to be planted.
- B. Newly Graded Subgrades:
 - 1. Loosen subgrade to a minimum depth of 6”.
 - 2. Remove stones larger than 1” in any dimension, sticks, roots, trash, and other extraneous matter.
 - 3. Apply soil amendments and fertilizer as recommended by topsoil analyst directly to topsoil before loosening.
- C. Unchanged Sub-grades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a minimum depth of 6”.
Remove stones larger than 1” any dimension, sticks, roots, trash, and other extraneous matter.
 - 3. Apply soil amendments and fertilizers according to topsoil analysis and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
- D. Finish Grading:
 - 1. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture.
 - 2. Grade to within plus or minus 1/2 inch of finish elevation.
 - 3. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.
- G. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

3.3 SEEDING

- A. General:
 - 1. Sow seed with spreader or seeding machine.
 - 2. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 3. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 4. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 5. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
 - 6. Unless otherwise indicated, sow seed at the rate of 4 to 6 lb./1000 sq. ft.
- B. Slope Protection:
 - 1. On slopes 5:1 and steeper, install erosion control blanket.

2. On slopes less than 5:1, install straw mulch.
 - a. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas.
 - b. Spread by hand, blower, or other suitable equipment.
 - c. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.

3.4 HYDROSEEDING

- A. Hydro-seeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydro-seed applications. Continue mixing until it is uniformly blended into homogeneous slurry suitable for hydraulic application.
 1. Mix slurry with starch based tackifier following manufacturer recommendations.
 - a. Super Tack Natural Tackifier web: www.fibramulch.com 1-888-298-9911
 - b. Star Tak 600 or Star Tak 100 web: www.chemstar.com 1-800-328-5037
 - c. Alternate starch-based products may be approved upon submission
- B. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.5 PROTECTION

- A. Description:
 1. Erect temporary barricades and warning signs to protect against pedestrians and vehicular traffic.

3.6 CLEANING

- A. Description:
 1. Immediately clean spills from paved and finished surface areas.
 2. Remove debris and excess materials from the project site.
 3. Dispose of protective barricades and warning signs at termination of lawn establishment.
 4. Remove erosion control measures after lawn establishment period.

3.7 LAWN ESTABLISHMENT

- A. Watering:
 1. Water daily for the first 14 days after seeding.
 2. After first 14 days, supplement rainfall to produce a total of 2 inches of water per week until lawn is clearly established and growing healthy.
- B. Mowing:

1. When grass reaches 2-1/2 inches in height, mow to 1-3/4 inch in height.
2. Maintain grass between 1-3/4 inch and 2-1/2-inch height.
3. Do not cut off more than 40% of grass leaf in single mowing.
4. Remove grass clippings.
5. Re-seed spots larger than 1 square foot not having uniform strands of grass.

C. Weed Eradication:

1. Between second and third mowing, apply herbicide uniformly at manufacturer recommended rate.

D. Fertilizer:

1. Apply fertilizer uniformly at 1 lb. of nitrogen per 1000 square feet 30 days and 60 days after seeding and water immediately.

E. Satisfactory Seeded Lawn:

1. At end of maintenance period, a healthy, uniform, close stand of grass has been established free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 inches by 5 inches.

3.8 WARRANTY AND MAINTENANCE

A. Begin maintenance of lawns immediately after each area is seeded and continue until acceptable lawn is established, but not less than 60 days after date of Substantial Completion.

1. If full maintenance period has not elapsed before the end of planting season, or if lawn is not fully established, continue maintenance during the next planting season.
2. Maintenance includes watering, fertilizing, weeding, mowing, trimming, replanting, and other operations to provide a uniform, weed free, smooth lawn.

B. Begin the warranty period after the date of Substantial Completion and continue for a period of (one full year).

1. The warranty specified in this section does not deprive the Owner of other rights; he may have in these specifications.
2. The warranty period for new lawn areas shall be for (one full year) after date of Substantial Completion against defects including death and unsatisfactory growth except for defects resulting from Owner abuse or neglect or incidents beyond Contractor's control.
3. Replacement seeding under this warranty shall be granted for (one full year) from date of installation and acceptance.
4. The Contractor shall, at no cost to the Owner, repair damage done to walks, buildings, roads, and other plants or lawns during reseeding.
5. Inspection of the lawn to determine its completion for the beginning of the warranty period will be made by the Architect/Engineer upon notice requesting such inspection by the Contractor at least seven (7) days prior to the anticipated inspection date.

3.9 FINAL INSPECTION AND ACCEPTANCE

A. Description:

1. Request final inspection in writing for acceptance at least ten (10) days before end of warranty period.
2. At the end of the warranty period on the completed lawn, and on written notice from the Contractor, the Architect/Engineer will, within 15 days of such written notice, inspect the lawn to determine if a satisfactory stand of grass has been produced.
3. If a satisfactory lawn has not been established, another inspection will be made after written notice from the Contractor that the lawn is ready for inspection following the next growing season.

END OF SECTION

SECTION 33 05 00 – COMMON WORK RESULTS FOR UTILITIES

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. All utility systems 5 feet outside the building line, as shown or implied in the Contract Documents and as required for the Work, including but not limited to:
 - a. Water distribution.
 - b. Sanitary sewage.
 - c. Storm drainage.
2. The contractor is responsible for all utility work as shown on contract documents or as required, unless specifically indicated otherwise.

B. Related Sections:

1. Division 02 Section "Maintenance of Existing Conditions".
2. Division 33 Section "Site Water Distribution".
3. Division 33 Section "Sanitary Sewers".
4. Division 33 Section "Storm Drainage".

I.2 SUBMITTALS

- A. Warning Tape System.

I.3 DEFINITIONS

- A. Utilities include all underground and above ground piping, conduits, cables and related structures and appurtenances. Utilities also include sewers.
- B. "Utility Companies" as referenced herein includes all public, private and other companies and agencies supplying utility services or having jurisdiction over such services.

I.4 QUALITY ASSURANCE

- A. All materials and installation shall meet the requirements of utility companies.
- B. All installations shall meet the requirements and recommendations of the material manufacturers and suppliers.

- C. All installations shall meet the requirements and recommendations of the material manufacturers and suppliers.

I.5 COORDINATION

- A. All installations shall meet the requirements and recommendations of the material manufacturers and suppliers.
- B. Verify all proposed utility work with utility companies prior to beginning work.
- C. Provide sufficient notice to utility companies for all work affecting the services of utility companies.
- D. The contractor shall always maintain complete and operable utility services.
- E. Coordinate timing of utility work and temporary measures with Owner and Utility Companies.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Warning Tape:
 - 1. Verify warning tape requirements with Utility Companies, Owner and Architect/Engineer prior to installation. Unless otherwise indicated or required, provide per the following.
 - 2. Color:
 - a. Blue: Water, fire and chilled water lines.
 - b. Red: Electric.
 - c. Orange: Telecommunications.
 - d. Yellow: Gas, oil, steam, dangerous materials.
 - e. Green: Sanitary laterals
 - 3. Use one of the following systems:
 - a. Non-detectable warning tape with toning wire below:
 - 1) Acid- and alkali-resistant polyethylene warning tape manufactured for marking and identifying underground utilities, 6" inches wide and 4 mils thick.
 - 2) Label: continuous "CAUTION—BURIED (name of utility) BELOW".
Toning wire: 12-gauge copper wire with protective jacket for corrosion protection.
 - 3) Unless otherwise indicated, install warning tape 18" below finished grade with toning wire 12" below warning tape.
 - 4) Turn up and tie toning wire as indicated or as required by Utility Companies and Owner.
 - b. Detectable warning tape:

- 1) Acid- and alkali-resistant polyethylene warning tape manufactured for marking and identifying underground utilities, 6" inches wide and 4 mils thick with metallic core with protective jacket for corrosion protection.
 - 2) Label: continuous "CAUTION—BURIED (name of utility) BELOW".
 - 3) Unless otherwise indicated, install warning tape 18" below finished grade.
- B. Unless otherwise indicated or required, warning tape does not apply to sewers or subsurface drains.
- C. Refer to individual Sections for further utility product specifications.

PART 3 - EXECUTION

3.1 REQUIREMENTS

- A. General:
1. New utilities shall be installed and operational prior to displacing existing utilities. Service must be always maintained.
 2. All work shall be always made readily accessible for inspection by Utility Companies and Owner during working hours.
 3. Refer to Division 31 Section "Earthwork" for excavation, trenching and backfilling.
- B. Preparation:
1. Verify existing utilities and topographic conditions prior to trenching, excavation or installation.
 2. If existing field conditions prevent installation per the contract documents, notify the Architect/Engineer immediately.
 3. Review proposed utility work prior to installation and notify Architect/Engineer immediately of any conflicts or concerns.
 4. Mark underground utilities prior to beginning any excavation or other underground work around proposed activity.
- C. Installation:
1. Provide and maintain all necessary stakes, benchmarks and batter boards for installing utilities to alignment and grades.
 2. During backfilling, install continuous warning tape over all utilities. Install tape full length of the utility and terminate properly to allow for charging of tape or toning wire. If utility is installed by Utility Companies, provide warning tape and coordinate installation.

END OF SECTION

SECTION 33 10 00 - SITE WATER DISTRIBUTION

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Water and fire services outside of the building.

B. Related Sections:

1. Division 33 Section "Common Work Results for Utilities".
2. Division 28 Section "Fire Alarm" for fire protection supervision devices.

I.2 SUBMITTALS

A. Product Data for the following:

1. Pipe, fittings and joining materials.
2. Transition fittings.
3. Valves, hydrants and tapping sleeves.
4. Other water specialties and accessories required for Work.

B. Water line cleaning and test reports.

C. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Closeout Procedures", include the following:

1. Valves.
2. Fire hydrants.

I.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles and dimensional requirements of piping and specialties and are based on the specific system indicated. Refer to Division 01 Section "Quality Requirements."

B. Regulatory Requirements:

1. Comply with requirements of utility company supplying the water ("Water Company").
2. Comply with requirements of local fire department ("Fire Department").
3. Comply with the standards of authorities having jurisdiction for potable water services, including materials, installation, testing and disinfections.
4. Comply with standards of authorities having jurisdiction for fire suppression systems, including materials, hose threads, installation and testing.

C. Other:

1. Piping material shall bear labels, stamps, or other markings of specified testing agencies.
2. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
3. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
4. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
5. NSF Compliance:
 - a. NSF 14 for plastic potable water-service piping.
 - b. NSF 61 for material for water-service piping and specialties for domestic water.

I.4 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport:

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

B. Delivery:

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

C. Storage:

1. Do not remove valve or hydrant protectors unless necessary for inspection, then reinstall for storage.
2. Protect valves and hydrants from weather. Store indoors and maintain temperature higher than ambient dewpoint temperature.
3. Support valves and hydrants off the ground or pavement in watertight enclosures when outdoor storage is necessary.
4. Protect stored piping from moisture and dirt. Elevate above grade.
5. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

D. Handling:

1. Use slings to handle valves if size requires handling by crane or lift.
2. Rig valves to avoid damage to exposed parts.
3. Do not use hand wheels or stems as lifting or rigging points.

I.5 PROJECT CONDITIONS

- A. Do not interrupt existing utility services unless approved and coordinated with Owner. Refer to Division 02 Section "Maintenance of Existing Conditions".
- B. Maintain 18" vertical and 10' horizontal separation between all water lines and storm and sanitary sewers.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products and materials must meet the requirements and specifications of the Water Company and Fire Department. Contact Water Company and Fire Department and confirm products and materials are approved prior to ordering or installing.
- B. Unless otherwise indicated, pipe sizes refer to the nominal inside diameter.
- C. Unless otherwise indicated or required by Water Company, Fire Department or Owner, the following materials shall be used as described below.

2.2 PIPING MATERIALS

- A. Ductile Iron Pipe and Fittings (4" through 16"):
 - 1. Piping: AWWA C151, pressure class 350, bell and plain spigot end.
 - 2. Fittings: Ductile iron AWWA C110 standard pattern or AWWA C153 compact pattern.
 - 3. Joints: Every joint shall be restrained:
 - a. Rubber Field Lok 350 Gasket (U.S. Pipe) or approved equal.
 - b. Restrained mechanical joint (EBAA Megalug) or approved equal, with rubber gasket per AWWA C111.
 - c. Unrestrained mechanical joints are not acceptable.
 - d. Concrete thrust blocking is not acceptable.
 - 4. Interior lining: cement-mortar lining with seal coat per AWWA C104.
 - 5. Exterior coating: standard asphaltic coating per AWWA C151.
 - 6. Polyethylene encasement: AWWA C105 tube or sheet, Linear Low Density (LLD, minimum 8 mil) or High-Density Cross Laminated (HDCL, minimum 4 mil) with 2" wide polyethylene tape (minimum 12 mil).
- B. PVC Pipe and Fittings (4" through 12"):
 - 1. Piping: AWWA C900, DR 18, pressure class 235 psi, bell and plain-spigot end. Piping shall be same outside diameter as ductile iron and of a blue tint.
 - 2. Fittings:
 - a. Ductile iron AWWA C110 standard pattern or AWWA C153 compact pattern.

- b. Interior cement lining and seal coat per AWWA C104.
 - c. Exterior asphaltic coating per AWWA C151.
 - d. Polyethylene encasement: AWWA C105 tube or sheet, Linear Low Density (LLD, minimum 8 mil) or High-Density Cross Laminated (HDCL, minimum 4 mil) with 2" wide polyethylene tape (minimum 12 mil).
 - 3. Joints: Every joint shall be restrained.
 - a. Restrained mechanical joint (2000PV or 1600 Series by EBAA or approved equal) with elastomeric gasket per AWWA C111.
 - b. Unrestrained mechanical joints are not acceptable.
 - c. Concrete thrust blocking is not acceptable.
- C. HDPE Pipe and Fittings (4" through 12"):
 - 1. Piping:
 - a. Polyethylene Pipe shall conform to ANSI/AWWA C901 and ANSI/AWWA C906
 - b. Pipe material used shall conform to the PE Standard PE 3408 high density polyethylene pipe meeting ASTM D3350, SDR9 pressure class 200 psi, bell and plain spigot end.
 - c. Piping shall be same outside diameter as ductile iron and of a blue tint or have a co-extruded blue striping for identification.
 - 2. Fittings:
 - a. Molded fittings shall be manufactured and tested in accordance with ASTM D3261 and ASTM D2682 and shall be so marked.
 - b. Fitting shall also be tested in accordance with AWWA C906.
 - 3. Joints:
 - a. Butt fusion joints shall be PE4308 HDPE and approved for AWWA use.
 - b. Shall meet the requirements of the pipe to which they are to be fused.
 - c. Shall be manufactured in accordance with AWWA C906 with a minimum pressure class of 200 psi
- D. Transition Fittings (Joining Dissimilar Materials):
 - 1. Manufactured couplings or fittings compatible with piping materials, outside diameter and system working pressure.

2.3 VALVES

- A. Gate Valves (4" and greater):
 - 1. AWWA C515, FM approved, ductile iron body, minimum 200 psi working pressure rating
 - 2. Interior 6 mils fusion epoxy coating per AWWA C550, bronze stem and nut, non-rising stem.
 - 3. End connections: restrained mechanical joint.

4. Seat: resilient molded rubber seat per ASTM D2000.
5. Application: water lines 4" and greater.

2.4 OTHER

A. Tapping Sleeve Assemblies:

1. Stainless steel, two-piece bolted sleeve with flanged outlet for new branch connection.
2. Comply with AWWA C207 and MSS SP-60.
3. Include sleeve and valve compatible with drilling machine.
4. Include sleeve matching size and type of pipe material being tapped and with recesses flange for branch valve.
5. Approved manufacturers:
 - a. Mueller Company; Water Products Division.
 - b. JCM Industries

B. Valve Boxes:

1. AWWA M44 cast-iron.
2. Adjustable top section extension of length required for depth of burial of valve.
3. Bottom section with base of size to fit over valve.
4. Approximate 5" diameter barrel and plug with lettering "WATER".
5. Operating wrenches: steel, tee-handle with one pointed end, stem of length to operate deepest buried valve and socket matching valve operating nut.

C. Freestanding Fire Hydrants:

1. Dry barrel, AWWA C502. UL listed and FM approved.
2. Minimum working pressure 200 psi and minimum test pressure 400 psi.
3. Hydrants shall meet the requirements and standards of the Water Company and Fire Department.
4. Contact the Water Company and Fire Department and verify all requirements.

D. Corporation Valves:

1. Service-saddle assemblies shall meet AWWA C800.
2. It includes saddles and valves compatible with tapping machines.
3. Service-saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
4. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.

E. Curb Valves:

1. Comply with AWWA C800.
2. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
3. Service boxes: Similar to AWWA M44 requirements for cast-iron valves boxes.

4. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over curb valve, and approximately 3-inch diameter barrel.
5. Shutoff rods: Steel, tee-handle with one pointed end, stem length to operate deepest buried valve, and slotted end matching curb valve.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Division 31 Section "Earthwork" and Drawings for excavation, trenching and backfilling.
- B. Identification: Install continuous underground detectable warning tape over all water lines during backfilling. See Division 33 Section "Common Work Results for Utilities" for underground warning tapes and further information.
- C. Do not use flanges, unions or keyed couplings for underground piping.

3.2 CONNECTIONS

- A. Water Company Mains:
 1. Contact the Water Company and verify the size, location, materials and all other requirements for connection.
 2. Connect to Water Company mainly in accordance with the Water Company's requirements and specifications.
 3. Connections to Water Company mains shall be hot tapped, unless otherwise specified on Drawings or agreed to in writing by Water Company.
 4. The Contractor is responsible for all costs and fees associated with connecting to Water Company mains.
- B. Owner Lines:
 1. Connections to existing Owner lines shall be hot tapped, unless specified otherwise on Drawings or agreed to in writing by Owner.
 2. Contact Owner and coordinate connections.
 3. Existing water service shall be always maintained.

3.3 PIPING INSTALLATION

- A. General:
 1. Comply with NFPA 24 for fire-service-main piping material and installation.
 2. Install ductile iron water service piping according to AWWA C600 and AWWA M41.
 3. Install PVC pipe according to AWWA M23 and ASTM F645.
 4. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
 5. Install fittings for all changes in direction and for branch connections.

6. Unless otherwise indicated, install two 45-degree fittings at all horizontal and vertical 90-degree changes in direction.
7. Unless otherwise indicated, install all water piping with a minimum 60" burial depth, from top of pipe to top of finished grade, for frost protection. If local conditions or regulations warrant, increase burial depth such that the top of the pipe is at least 12" below the maximum frost penetration depth.

3.4 FIRE HYDRANT INSTALLATION

A. General:

1. Install each fire hydrant with separate gate valve in supply pipe.
2. Minimum size for supply line is 6".
3. Install with anchor coupling or other appropriate mechanically restrained method and support in upright condition. Do not use concrete thrust blocks, unless requested or required by the Water Company or Fire Department.
4. Comply with NFPA 24.

3.5 JOINT RESTRAINT

A. General:

1. Every joint shall be restrained. Un-restrained push-on joints or plain mechanical joints are not acceptable. Refer to Part 2 for each type of pipe.
2. Fire hydrants shall utilize anchor couplings or other appropriate restraining methods.
3. Apply a full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. Gate Valves:

1. Comply with AWWA C600, AWWA M44 and NFPA 24.
2. Install each underground valve with stem pointing up and with valve box.

- B. Corporation stops unless otherwise required by the Water Company or Owner, do not install service saddles on ductile iron pipe. Use saddles on plastic pipe as specified in Part 2.

3.7 CLEANING AND TESTING

A. Cleaning:

1. Purge new water piping systems and parts of existing systems which have been altered, extended or repaired before being put in service.
2. Contact the Water Company to coordinate cleaning and disinfection and meet all requirements and specifications of the Water Company.
3. If the method is not prescribed by Water Company, use procedure per AWWA C651.

4. Submit reports of cleaning and disinfecting to Water Company and Architect/Engineer.

B. Testing:

1. The contractor is responsible for all costs for testing and inspection, including labor, equipment and supplies.
2. The contractor is responsible for coordinating and scheduling testing.
3. Any work failing testing and inspection requirements shall be repaired or replaced and retested at the Contractor's expense.
4. All testing shall be done per the Water Company requirements and specifications.
5. Contact the Water Company and coordinate all the testing.
6. If testing requirements are not specified by the Water Company, the following shall be used:
 - a. Conduct piping tests before joints are covered (and after thrust blocks have hardened sufficiently, if applicable).
 - b. Fill pipeline 24 hours before testing and apply test pressure to stabilize system.
 - c. Ensure all air has been expelled from lines.
 - d. Hydrostatic test: Test at not less than 1-1/2 times the working pressure (but not more than the rated pressure) for 2 hours.
 - e. Increase pressure in 50-psig increments and inspect each joint between increments.
 - f. Hold at pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour.
 - g. Maximum allowable leakage is 2 quarts per hour per 100 joints.

- C. Prepare reports of cleaning and testing and submit to Water Company and Architect/Engineer.

END OF SECTION

SECTION 33 30 00 - SANITARY SEWERS

PART I - GENERAL

I.1 SUMMARY

A. Section Includes:

1. Sanitary sewers outside of the building.

B. Related Sections:

1. Division 33 Section "Common Work Results for Utilities".

I.2 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with the requirements of the utility company which receives the wastewater and otherwise has authority over the sanitary infrastructure "Sanitary Utility".
2. All materials and work within the right-of-way or easement of any local government or other agency having jurisdiction over sewage, shall meet the requirements of such an agency.
3. All sanitary work and testing shall conform to the Indiana Department of Environmental Management (IDEM) and the Indiana State Department of Health (ISDH).

I.3 SUBMITTALS

- A. General: Each item in submittal must state that the item meets or exceeds the specified standards referenced herein. In addition, if multiple sizes or types are included in the submittal, clearly indicate which is to be used, and where, if applicable.

B. Product Data:

1. Sewer pipe, fittings and joint materials.
2. Pipe connectors (flexible connectors into sanitary manholes).
3. Cleanouts.

C. Shop Drawings:

1. Pre-cast concrete manholes, including castings, steps, sealing materials and any other required appurtenances.

- D. Test Reports: Submit results for all testing and inspections to Architect/Engineer.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Notes:

1. Unless otherwise indicated, pipe sizes refer to the nominal inside diameter.
2. Unless otherwise indicated, the following materials shall be used as described below.

B. Sanitary Sewer:

1. Polyvinyl chloride (PVC) pipe and fittings (6" through 15"):
 - a. Pipe: ASTM D3034, SDR-35.
 - b. Fittings: ASTM D3034, SDR-35.
 - c. Joints: ASTM D3212, compression bell and spigot.
 - d. Gaskets: ASTM F477, elastomeric.
2. Ductile iron pipe and fittings (6" and larger):
 - a. Pipe: AWWA C151, pressure class 350.
 - b. Fittings: AWWA C110, standard pattern or AWWA C153 compact pattern.
 - c. Joints: bell and spigot with push-on joints and gaskets.
 - d. Gaskets: AWWA C111, rubber.
 - e. Interior lining: epoxy coating (do not use cement mortar lining).
 - f. Exterior coating: standard asphaltic per AWWA C151.
 - g. Polyethylene encasement: AWWA C105 tube or sheet, Linear Low Density (LLD, minimum 8 mil) or High-Density Cross Laminated (HDCL, minimum 4 mil) with 2" polyethylene tape (minimum 12 mil).
 - h. Application: Required when crossing water lines with less than 18" vertical or 10' horizontal clearance.

2.2 EXTERIOR CLEANOUTS

A. General:

1. Unless otherwise indicated, cleanouts shall be the same diameter as the sewer they serve for pipe sizes up to 8", pipes greater than 8" shall use an 8" cleanout.
2. Unless otherwise indicated, riser pipes and cleanout bodies shall be the same material as the sewer they serve.
3. Each cleanout shall have an exterior housing to prevent transfer of load to the cleanout.
4. Medium duty housing may be used in non-vehicular areas, all others shall be heavy duty.
5. Exterior housing:
 - a. ASME A112.36.2M gray iron with round, secured, scoriated and gray iron cover.
 - b. Refer to Part 3 for concrete anchorage.
6. Cast iron cleanouts:

- a. Gray iron ferrule with tapered-thread, brass closure plug, ASME A112.36.2M.
 - b. Riser pipe and fittings: cast iron soil pipe, ASTM A74.
 - c. Ferrule connection may be inside caulk, spigot or no-hub. The connection must be water and airtight.
7. Plastic cleanouts:
- a. PVC body with PVC tapered thread plug.
 - b. Riser pipe and fittings: SDR 35, ASTM D3034.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping:

1. Install PVC gravity sewer piping according to ASTM D2321.
2. Install cleanouts and manholes in sewer lines where shown on the Drawings and as required by applicable Codes and/or field conditions.
3. Install manholes and cleanouts at all changes in direction. Blind turns or gradual deflection of pipe is not permitted.
4. The maximum distance between manholes is 400'.
5. Verify existing and proposed grades before installing any pipe. Notify Architect/Engineer of any conflicts with Drawings or Specifications.
6. Pipe installation shall proceed with spigot ends of bell and spigot pipe pointing into direction of flow. Each pipe shall be laid true to line and grade and in such a manner as to form a close concentric joint with adjoining pipe and to prevent sudden offset in the flow line.
7. Pipe trenches shall be excavated parallel to the specified pipe, slope and grade. The bottom of the pipe shall be supported by a minimum 6" thick layer of #8 crushed stone. The #8 crushed stone shall extend 6" on each side of the pipe and 12" above the top of the pipe. The remaining backfill in lawn and non-pavement areas shall be suitable fill material approved by the Geotechnical Engineer. Pipes under and within 5' of pavements, slabs, sidewalks and other hard surfaces shall be backfilled with compacted granular fill. All backfilling and compaction shall be in accordance with Division 31 Section "Earthwork".
8. During backfilling, install detectable warning tape. See Division 33 Section "Common Work Results for Utilities" for warning tape requirements.
9. Any breaks or defects in pipe must be immediately repaired. Any pipe which has been disturbed after being laid must be taken up, joints cleaned and properly re-laid.
10. The interior of all pipes shall be cleaned of all dirt and superfluous materials as the work progresses. After pipe installation, install erosion control measures as shown on Drawings and as necessary to prevent sediment or other materials from entering or building up in pipe.
11. Water and sewer minimum clearances:
 - a. Where minimum 18" vertical or 10' horizontal separation cannot be provided between sewers and water lines, the sewer shall be ductile iron, refer to Part 2.

- b. At crossings, extend ductile iron sewer pipe a minimum of 10 feet on both sides of the water line.
- c. Do not install water and sewer lines in the same trench under any circumstances.

B. Cleanouts:

- 1. Install piping so cleanouts open in direction of flow in sewer pipe.
- 2. Set clean out covers flush with grade.
- 3. In areas other than concrete walks and concrete pavements, install concrete anchor pad.
- 4. Unless otherwise indicated, pad dimensions are 12" height with a diameter of the cleanout housing diameter + 12", to provide a 6" ring around the cleanout frame. Place on properly compacted subgrade and stone per Division 31 Section "Earthwork" and Division 32 Section "Site Concrete".

3.2 SANITARY SEWER TESTING

A. General:

- 1. The Contractor is responsible for all costs for testing and inspection, including labor, equipment and supplies.
- 2. The Contractor is responsible for coordinating and scheduling testing.
- 3. Any work failing testing and inspection requirements shall be repaired or replaced at the Contractor's expense and re-tested.

B. Requirements:

- 1. Testing and inspection shall meet all requirements of local Sanitary Utility and applicable State regulations. The contractor shall contact the local Sanitary Utility to verify testing and inspection requirements.

C. Gravity Sewer Pipe:

- 1. Deflection test: No sooner than 30 days after the installation, backfill and final compaction, each flexible sewer pipe shall be tested for deflection. No pipe shall exceed a deflection of 5%. The diameter of the mandrel shall be no less than 95% of the inside diameter of the pipe. The test shall not be performed with the aid of a mechanical pulling device.
- 2. Air pressure test: Each flexible sewer pipe shall be air pressure tested and conform to ASTM F1417. The leakage exfiltration or infiltration shall not exceed 200 gallons per inch of pipe diameter per mile per day for any section of pipe with a minimum positive head of two feet.

END OF SECTION

SECTION 33 40 00 – STORM DRAINAGE

PART I - GENERAL

I.1 SUMMARY

- A. Section Includes:
 - 1. Storm sewers and drainage structures outside of the building.
- B. Related Sections:
 - 1. Division 33 Section “Common Work Results for Utilities”.

I.2 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. All materials and work within the right-of-way or easement of any local government or other agency having jurisdiction over storm drainage, shall meet the requirements of such an agency.

I.3 SUBMITTALS

- A. Each item in submittal must state that the item meets or exceeds the specified standards referenced herein. If multiple sizes or types are included in the submittal, clearly indicate which are to be used, and where, if applicable.
- B. Product Data:
 - 1. Sewer pipe, fittings and joint materials.
 - 2. Frames and grates.
 - 3. Steps.
 - 4. Cleanouts.
 - 5. End sections.
- C. Shop Drawings: Reinforced concrete manholes, inlets, and any other structures, including steps, sealing materials and any other required appurtenances.
- D. Test Reports: Submit results for all testing and inspections to Architect/Engineer.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Unless otherwise indicated, pipe sizes refer to the nominal inside diameter.
- B. Unless otherwise indicated, the following materials shall be used as described below.
 - 1. Reinforced concrete pipe (RCP):
 - a. ASTM C76, Class III, Wall B.
 - b. Bell and spigot joints with rubber gaskets ASTM C443.
 - c. Application: Storm sewers 12" and larger.
 - 2. Polyvinyl chloride (PVC) pipe and fittings:
 - a. SDR 35 ASTM D1784, ASTM D3034.
 - b. Compression type bell and spigot joints ASTM D3212 with ASTM F477 gaskets.
 - c. Application: Storm sewer 12" and smaller which runs directly from building. Do not use in between storm structures or for culverts.
 - 3. Ductile iron (DI) pipe and fittings:
 - a. Pipe: AWWA C151, pressure class 350.
 - b. Fittings: AWWA C110, standard pattern or AWWA C153 compact pattern.
 - c. Joints: bell and spigot with push-on joints and gaskets.
 - d. Gaskets: AWWA C111, rubber.
 - e. Interior lining: epoxy coating (do not use cement mortar lining).
 - f. Polyethylene encasement: AWWA C105 tube or sheet, Linear Low Density (LLD, minimum 8 mil) or High-Density Cross Laminated (HDCL, minimum 4 mil) with 2" polyethylene tape (minimum 12 mil).
 - g. Application: Sewers 6" and larger. Required when crossing water lines with less than 18" vertical or 10' horizontal clearance.
- C. End Sections:
 - 1. Precast reinforced concrete for RCP piping.

2.2 EXTERIOR CLEANOUTS

- A. General:
 - 1. Unless otherwise indicated, cleanouts shall be the same diameter as the sewer they serve for pipe sizes up to 8", pipes greater than 8" shall use an 8" cleanout.
 - 2. Unless otherwise indicated, riser pipes and cleanout bodies shall be the same material as the sewer they serve.
 - 3. Each cleanout shall have an exterior housing to prevent transfer of load to the cleanout.
 - 4. Medium duty housing may be used in non-vehicular areas, all others shall be heavy duty.
 - 5. Exterior housing:

- a. ASME A112.36.2M gray iron with round, secured, scoriae and gray iron cover.
 - b. Refer to Part 3 for concrete anchorage.
6. Cast iron cleanouts:
 - a. Gray iron ferrule with tapered-thread, brass closure plug, ASME A112.36.2M.
 - b. Riser pipe and fittings: cast iron soil pipe, ASTM A74.
 - c. Ferrule connection may be inside caulk, spigot or no-hub; however, connection must be water and air-tight.
7. Plastic cleanouts:
 - a. PVC body with PVC tapered thread plug.
 - b. Riser pipe and fittings: SDR 35, ASTM D3034.

2.3 MANHOLES AND CATCH BASINS

A. General:

1. Precast concrete per ASTM C478.
2. Manhole base shall be minimum 8" thick. To prevent flotation, increase thickness of precast sections or add concrete to base section as required.
3. Steps: Polypropylene encased #4 rebar per ASTM D4101, meeting OSHA requirements.
4. Castings: All frames and castings shall be heavy duty and constructed of gray iron free from blowholes, porosity, hard spots, shrinkage distortion, etc. They shall be smooth and clean.
5. Adjusting rings: Precast concrete, interlocking with ½ butyl rubber base or extrudable preformed gasket material. Bricks, blocks or other means are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping:

1. Cleanouts and manholes shall be installed in sewer where shown on the Drawings and as required by applicable Codes and/or field conditions.
2. Install manholes and cleanouts at all changes in direction. Blind turns or gradual deflection of pipe is not permitted.
3. The maximum distance between manholes is 400'.
4. Verify existing and proposed grades, connections and pipe sizes before installing any pipe. Notify Architect/Engineer of any conflicts with Drawings or Specifications.
5. Pipe installation shall proceed with spigot ends of bell and spigot pipe pointing into direction of flow.
6. Each pipe shall be laid true to line and grade and in such a manner as to form a close concentric joint with adjoining pipe and to prevent sudden offset in the flow line.
7. During backfilling, install detectable warning tape. See Division 33 Section "Common Work Results for Utilities" for warning tape requirements.

8. Pipe trenches shall be excavated parallel to the specified pipe, slope and grade.
9. The bottom of the pipe shall be supported by a minimum 6" thick layer of #8 crushed stone. The #8 crushed stone shall extend 6" on each side of the pipe and 12" above the top of the pipe unless indicated otherwise.
10. The remaining backfill in lawn and non-pavement areas shall be suitable fill material approved by the soils testing laboratory.
11. Pipes under and within 5' of pavements, slabs, sidewalks and other hard surfaces shall be backfilled with compacted granular fill.
12. All backfilling and compaction shall be in accordance with Division 31 Section "Earthwork"
13. Any breaks or defects in pipe must be immediately repaired. Any pipe which has been disturbed after being laid must be taken up, joints cleaned and properly re-laid.
14. The interior of all pipes shall be cleaned of all dirt and superfluous materials as the work progresses. After pipe installation, install erosion control measures as shown on Drawings and as necessary to prevent sediment or other materials from entering or building up in pipe.
15. Water and sewer minimum clearances:
 - a. Where minimum 18" vertical or 10' horizontal separation cannot be provided between sewers and water lines, the sewer shall be ductile iron, refer to Part 2.
 - b. At crossings, extend ductile iron sewer pipe a minimum of 10 feet on both sides of the water line.
 - c. Do not install water and sewer lines in the same trench under any circumstances.

B. Manholes and Catch Basins:

1. Set solid lid castings flush with grade in pavement areas and 1" above grade in other areas. Set inlet castings at elevation grades per Drawings.
2. Install 2 to 4 precast adjusting rings for an overall 6" to 12" adjustment height.
3. Grade to drain into inlet castings positively and adequately.
4. Install steps from 12" below top to 12" above bottom at 16" on center.
5. Bench bottom of structures per Drawings.

C. Cleanouts:

1. Install piping so cleanouts open in direction of flow in sewer pipe.
2. Set clean out covers flush with grade.
3. In areas other than concrete walks and concrete pavements, install concrete anchor pad.
4. Unless otherwise indicated, pad dimensions are 12" height with a diameter of the cleanout housing diameter + 12", to provide a 6" ring around the cleanout frame. Place on properly compacted subgrade and stone per Division 31 Section "Earthwork" and Division 32 Section "Site Concrete".

END OF SECTION

