PROJECT MANUAL
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BROADVIEW SENIOR LIVING AT PURCHASE COLLEGE
INDEPENDENT LIVING, ASSISTED LIVING/ MEMORY CARE, & COMMONS

VOLUME 2: DIVISIONS 21 THROUGH 35

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SECTION 210517

SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Proco Products, Inc.

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

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

2.3 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

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. 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.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

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

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls below 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-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.

3. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

4. 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 210517

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SECTION 210518

ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

2.2 FLOOR PLATES

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

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 type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 210518

SECTION 210523

GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Check valves.
2. Iron OS&Y gate valves.
3. Indicator posts.
4. Trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HMER - Check Valves.
3) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

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

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 CHECK VALVES

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

1. NIBCO INC.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Viking Corporation.

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psiga.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.3 IRON OS&Y GATE VALVES

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

1. NIBCO INC.
2. Victaulic Company.
3. WATTS.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.4 INDICATOR POSTS

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

1. American Cast Iron Pipe Company.
2. Mueller Co.
3. NIBCO INC.

B. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: [**Underground**] [**Pit**] [**Wall**].
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Wrench.

2.5 TRIM AND DRAIN VALVES

A. Angle Valves:

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

   a. Fire Protection Products, Inc.
   b. NIBCO INC.
   c. United Brass Works, Inc.

2. Description:

   a. Pressure Rating: 175 psig.
   b. Body Material: Brass or bronze.
   c. Ends: Threaded.
   d. Stem: Bronze.

e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
2. Section 211200 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
3. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
4. Section 211316 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

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

G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 210523

SECTION 210553

IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Equipment labels.
      2) Warning signs and labels.
      3) Pipe labels.

2. ACTION SUBMITTALS

   a. Product Data: For each type of product.

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

2 PRODUCTS

1. EQUIPMENT LABELS

   a. Metal Labels for Equipment:

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

         a) Carlton Industries, LP.
         b) emedco.
         c) Kolbi Pipe Marker Co.

      2) Material and Thickness: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
      3) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
      4) 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.
      5) Fasteners: Stainless-steel rivets or self-tapping screws.
      6) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2. WARNING SIGNS AND LABELS

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

1) Craftmark Pipe Markers.
2) Marking Sevices Inc.
3) National Marker Company.

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

c. Letter Color: White.

d. Background Color: Red.

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

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

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

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

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

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

3. PIPE LABELS

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

1) Brady Corporation.
2) Carlton Industries, LP.
3) Kolbi Pipe Marker Co.

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

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

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

e. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

3 EXECUTION

1. PREPARATION

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

2. LABEL INSTALLATION REQUIREMENTS

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

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

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

d. Locate equipment labels where accessible and visible.

e. Piping: Painting of piping is specified in [**Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

f. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1) Near each valve and control device.
2) Near each branch connection excluding short takeoffs. 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 a 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.

END OF SECTION 210553

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SECTION 210700

FIRE-SUPPRESSION SYSTEMS INSULATION

1 GENERAL

1. SUMMARY

a. Section Includes:
   1) Insulating indoor and outdoor equipment.
   2) Insulating outdoor piping.

2. ACTION SUBMITTALS

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

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

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

3. INFORMATIONAL SUBMITTALS

a. Field quality-control reports.

4. QUALITY ASSURANCE

a. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, 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.

2 PRODUCTS

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

a) Pittsburgh Corning Corporation.

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

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

a) Foster Brand; H. B. Fuller Construction Products.

3. SEALANTS

a. Joint Sealants for Cellular-Glass Products:

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

a) Foster Brand; H. B. Fuller Construction Products.
b) Pittsburgh Corning Corporation.

2) Materials shall be compatible with insulation materials, jackets, and substrates.
3) Permanently flexible, elastomeric sealant.
4) Service Temperature Range: Minus 100 to plus 300 deg F.
5) Color: White or gray.

b. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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

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

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

4. FIELD-APPLIED JACKETS

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

b. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

a) Johns Manville; a Berkshire Hathaway company.

2) Adhesive: As recommended by jacket material manufacturer.
3) Color: Color-code jackets based on system. Color as selected by Architect.
4) Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5) Factory-fabricated tank heads and tank side panels.

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

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

a) RPR Products, Inc.

2) Factory cut and rolled to size.

3) Finish and thickness are indicated in field-applied jacket schedules.
4) Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
5) Factory-Fabricated Fitting Covers:

a) Same material, finish, and thickness as jacket.
b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
c) Tee covers.
d) Flange and union covers.
e) End caps.
f) Beveled collars.
g) Valve covers.
h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

5. TAPES

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

1) Width: 3 inches.
2) Thickness: 11.5 mils.
3) Adhesion: 90 ounces force/inch in width.
4) Elongation: 2 percent.
5) Tensile Strength: 40 lbf/inch in width.
6) ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

b. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1) Width: 2 inches.
2) Thickness: 6 mils.
3) Adhesion: 64 ounces force/inch in width.
4) Elongation: 500 percent.
5) Tensile Strength: 18 lbf/inch in width.

c. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1) Width: 2 inches.
2) Thickness: 3.7 mils.
3) Adhesion: 100 ounces force/inch in width.
4) Elongation: 5 percent.
5) Tensile Strength: 34 lbf/inch in width.

6. SECUREMENTS

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

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

a) ITW Insulation Systems; Illinois Tool Works, Inc.
b) RPR Products, Inc.

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

c. Wire: 0.062-inch soft-annealed, stainless steel.

7. CORNER ANGLES

a. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

b. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

3 EXECUTION

1. PREPARATION

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

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

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

2. GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

g. Keep insulation materials dry during application and finishing.

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

i. Install insulation with least number of joints practical.

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

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

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

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

1) Draw jacket tight and smooth.
2) Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3) Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a) For below-ambient services, apply vapor-barrier mastic over staples.

4) Cover joints and seams with tape, 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. PENETRATIONS

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

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

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

c. Insulation Installation at Floor Penetrations:

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

4. GENERAL PIPE INSULATION INSTALLATION

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

b. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

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

6) Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7) Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8) For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9) Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

c. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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.

5. CELLULAR-GLASS INSULATION INSTALLATION

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 applicable insulation 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.
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.

6. FIELD-APPLIED JACKET INSTALLATION

a. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

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

b. 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.

7. FINISHES

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

1) Flat Acrylic Finish: 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. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

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

8. FIELD QUALITY CONTROL

a. Perform tests and inspections.

b. 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, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

9. PIPING INSULATION SCHEDULE, GENERAL

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

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

1) Indoor fire-suppression piping.
2) Underground piping.

10. INDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

a. Fire-Suppression Water Piping:

1) All Pipe Sizes: Insulation shall be the following:

a) Cellular Glass: 2 inches (50 mm) thick.

11. INDOOR, FIELD-APPLIED JACKET SCHEDULE

a. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

b. If more than one material is listed, selection from materials listed is Contractor's option.

c. Piping, Concealed:

1) Aluminum, Smooth: 0.016 inch thick.

d. Piping, Exposed:

1) PVC, Color-Coded by System: 20 mils thick.

END OF SECTION 210700

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SECTION 211100

FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

1 GENERAL

1. SUMMARY

a. Section includes fire-suppression water-service piping and related components outside the building and service entrance piping through floor into the building and the following:

1) Pipes, fittings, and specialties.
2) Fire-suppression specialty valves.
3) Protective enclosures.
4) Alarm devices.

b. Utility-furnished products include water meters that are furnished to the site, ready for installation.

c. Related Requirements:

1) Section 211116 "Facility Fire Hydrants" for AWWA and UL-listed, dry- and wet-barrel fire hydrants.
2) Section 211119 "Fire-Department Connections" for exposed-, flush-, and yard-type, fire-department connections.
3) Section 211200 "Fire-Suppression Standpipes" for fire-suppression standpipes inside the building.

2. ACTION SUBMITTALS

a. Product Data: For each type of product.

b. Shop Drawings:
1) Include diagrams for power, signal, and control wiring.

3. INFORMATIONAL SUBMITTALS

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

b. Field quality-control reports.

4. QUALITY ASSURANCE

a. Regulatory Requirements:

1) Comply with requirements of utility company supplying the water. Include tapping of water mains and backflow prevention.
2) Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

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

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

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

2 PRODUCTS

1. DUCTILE-IRON PIPE AND FITTINGS

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

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

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

a) Tyco by Johnson Controls Company.
b) Victaulic Company.
c) Viking Corporation.

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

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

2. SPECIAL PIPE FITTINGS

a. Ductile-Iron Flexible Expansion Joints:

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

a) Romac Industries, Inc.
b) Zurn Industries, LLC.

2) Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
3) Pressure Rating: 250 psig minimum.

b. Ductile-Iron Deflection Fittings:

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

a) EBAA Iron, Inc.

2) Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
3) Pressure Rating: 250 psig minimum.

3. JOINING MATERIALS

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

4. PIPING SPECIALTIES

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

b. Tubular-Sleeve Pipe Couplings:

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

a) Jay R. Smith Mfg Co; a division of Morris Group International.
b) JCM Industries, Inc.
c) Viking Johnson.

2) Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
3) Standard: AWWA C219.
4) Center-Sleeve Material: Manufacturer's standard.
5) Gasket Material: Natural or synthetic rubber.
6) Pressure Rating: 150 psig minimum.
7) Metal Component Finish: Corrosion-resistant coating or material.

5. CORPORATION VALVES

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

1) Mueller Co.

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

1) Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2) Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
3) Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

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

6. CURB VALVES

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

1) Mueller Co.
2) Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.

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

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

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

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

7. BACKFLOW PREVENTERS

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

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

a) Mueller Co.
b) WATTS.
c) Zurn Industries, LLC.

2) Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
3) Operation: Continuous-pressure applications.
4) Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
5) End Connections: Flanged.
6) Configuration: Designed for horizontal, straight through flow.
7) Accessories:

a) Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.
b) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

8. ALARM DEVICES

a. General: UL 753 and FM Global's "Approval Guide" listing, of types and sizes to mate and match piping and equipment.

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

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

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

3 EXECUTION

1. EARTHWORK

a. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

2. PIPING INSTALLATION

a. Water-Main Connection: Arrange with water utility company for tap of size and in location indicated in water main.

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

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

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

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

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

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

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

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

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

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

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

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

j. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for fire-suppression-water piping inside the building.

k. Comply with requirements in Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

l. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

m. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

3. JOINT CONSTRUCTION

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

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

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

d. Ream ends of tubes and remove burrs.

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

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

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

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

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

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

4. ANCHORAGE INSTALLATION

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

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

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

1) Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2) Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

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

5. VALVE INSTALLATION

a. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

b. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

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

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

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

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

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

h. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]

6. DETECTOR CHECK VALVE INSTALLATION

a. Install aboveground.

b. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

c. Support detector check valves and piping on concrete piers. Comply with requirements for concrete piers in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]

7. BACKFLOW PREVENTER INSTALLATION

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

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

c. Do not install bypass piping around backflow preventers.

d. Support NPS 2-1/2 and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]

8. WATER METER BOX INSTALLATION

a. Install water meter boxes in paved areas flush with surface.

b. Install water meter boxes in grass or earth areas with top 2 inches above surface.

9. CONCRETE VAULT INSTALLATION

a. Install precast concrete vaults according to ASTM C 891.

10. FIRE-DEPARTMENT CONNECTION INSTALLATION

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

b. Install protective pipe bollards on two sides of each freestanding fire-department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

11. ALARM DEVICE INSTALLATION

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

b. Supervisory Switches: Supervise valves in open position.

1) Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2) Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

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

1) Valves: Install chain and padlock on open OS&Y gate valve.
2) Post Indicators: Install padlock on wrench on indicator post.

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

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

f. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in [**Section 283111 "Digital, Addressable Fire-Alarm System."**] [**Section 283112 "Zoned (DC Loop) Fire-Alarm System."**]

12. CONNECTIONS

a. Connect fire-suppression water-service piping to existing water main. Use tapping sleeve and tapping valve.

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

13. FIELD QUALITY CONTROL

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

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

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

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

d. Prepare test and inspection reports.

14. IDENTIFICATION

a. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

b. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel. Comply with requirements for identifying devices in Section 220553 "Identification for Plumbing Piping and Equipment."

15. PIPING SCHEDULE

a. Underground fire-suppression water-service piping shall be the following:

1) Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.

b. Underslab fire-suppression water-service piping shall be the following:

1) Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.

16. VALVE SCHEDULE

a. Underground fire-suppression water-service shutoff valves NPS 2 and smaller shall be corporation valves or curb valves with ends compatible with piping.

b. Meter box fire-suppression water-service shutoff valves NPS 2 and smaller shall be meter valves.

c. Vault fire-suppression water-service shutoff valves NPS 2 and smaller shall be UL-listed or FM Global-approved, OS&Y, bronze, gate valves.

d. Underground fire-suppression water-service shutoff valves NPS 3 and larger shall be the following:

1) 250-psig, AWWA, iron, nonrising-stem, resilient-seated gate valves.

e. Indicator-post underground fire-suppression water-service valves NPS 3 and larger shall be 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves with indicator-post flange.

f. Standard-pressure, aboveground and vault fire-suppression water-service shutoff valves NPS 3 and larger shall be the following:
1) 175-psig, UL-listed or FM Global-approved, iron, OS&Y gate valves.

g. Fire-suppression water-service check valves NPS 3 and larger shall be one of the following:

1) AWWA or UL-listed or FM Global-approved check valves.
2) UL-listed or FM Global-approved detector check valves.

END OF SECTION 211100

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SECTION 211119

FIRE-DEPARTMENT CONNECTIONS

1 GENERAL

1. SUMMARY

a. Section Includes:

1) Exposed-type fire-department connections.

2. ACTION SUBMITTALS

a. Product Data: For each type of product.

1) Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

2 PRODUCTS

1. EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

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

1) American Fire Hose & Cabinet.
2) Fire Protection Products, Inc.
3) Guardian Fire Equipment, Inc.

b. Standard: UL 405.

c. Type: Exposed, projecting, for wall mounting.

d. Pressure Rating: 175 psig minimum.

e. Body Material: Corrosion-resistant metal.

f. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

g. Caps: Brass, lugged type, with gasket and chain.

h. Escutcheon Plate: Round, brass, wall type.

i. Outlet: Back, with pipe threads.

j. Number of Inlets: Two.

k. Escutcheon Plate Marking: Similar to " STANDPIPE."

l. Finish: Polished chrome plated.

m. Outlet Size: NPS 6.

3 EXECUTION

1. INSTALLATION

a. Install wall-type fire-department connections.

b. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION 211119

SECTION 211200

FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Alarm devices.
5. Pressure gages.

B. Related Requirements:

1. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping."
2. Section 211119 "Fire-Department Connections" for exposed wall-mounted and yard fire hydrants.
3. Section 211213 "Fire-Suppression Hoses and Nozzles" for rack-type hose stations, reel-type hose stations, and monitors.
4. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
5. Section 211316 "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
6. [**Section 283111 "Digital, Addressable Fire-Alarm System"**] [**Section 283112 "Zoned (DC Loop) Fire-Alarm System"**] for connections to alarm devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-suppression standpipes.

1. Include plans, elevations, sections, and attachment details.

C. Delegated-Design Submittal: For standpipe 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.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and professional engineer.

B. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Fire-hydrant flow test report.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes 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. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

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

2.2 PERFORMANCE REQUIREMENTS

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

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

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

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

a. NPS 1-1/2 Hose Connections: 65 psig.
b. NPS 2-1/2 Hose Connections: 100 psig.

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

2.3 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A 795/A 795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.

B. Malleable- or Ductile-Iron Unions: UL 860.

C. Cast-Iron Flanges: ASME B16.1, Class 125.

D. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

E. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

F. Grooved-Joint, Steel-Pipe Appurtenances:

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

   a. National Fittings, Inc.
   b. Tyco by Johnson Controls Company.
   c. Victaulic Company.

2. Pressure Rating: 175 psig minimum.
3. Galvanized, 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.

2.4 GALVANIZED-STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A 795/A 795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.
4. Threaded ends.

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

F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:

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

a. Victaulic Company.

2. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
3. Fittings for Grooved-End, Galvanized-Steel Pipe:

a. AWWA C606 for steel-pipe dimensions.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating:

1) NPS 8 and Smaller: 600 psig.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.

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.

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

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

a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco by Johnson Controls Company.
c. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

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

   a. Reliable Automatic Sprinkler Co., Inc. (The).
   b. Tyco by Johnson Controls Company.

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

2.7 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:

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

   a. Tyco by Johnson Controls Company.
   b. Zurn Industries, LLC.

2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle or gate.
9. Finish: Polished chrome-plated.

2.8 ALARM DEVICES

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

B. Water-Motor-Operated Alarm:

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

   a. Tyco by Johnson Controls Company.
   b. Victaulic Company.
   c. Viking Corporation.

2. Standard: UL 753.
3. Type: Mechanically operated, with pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.

5. Size: 10-inch diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
8. Outlet: NPS 1 drain connection.

C. Electrically Operated Alarm Bell:

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

   a. Potter Electric Signal Company, LLC.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

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

   a. Potter Electric Signal Company, LLC.
   b. Viking Corporation.
   c. WATTS.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:

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

   a. Potter Electric Signal Company, LLC.
   b. Tyco by Johnson Controls Company.
   c. Viking Corporation.

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

F. Valve Supervisory Switches:

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

    a. Potter Electric Signal Company, LLC.

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

G. Indicator-Post Supervisory Switches:

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

    a. Potter Electric Signal Company, LLC.

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

2.9 PRESSURE GAGES

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

B. a. WIKA Instrument Corporation.Standard: UL 393.

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

D. Pressure Gage Range: Zero to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 WATER-SUPPLY CONNECTIONS

A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.

D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install drain valves on standpipes. Extend drain piping to outside of building.

F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

G. Install alarm devices in piping systems.

H. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

I. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

J. Fill standpipe system piping with water.

K. Install electric heating cables and pipe insulation on wet-type fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

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

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

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

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

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

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

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, 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.

I. 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.

J. Welded Joints: Construct joints according to AWS D10.12/D10.12M, 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.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.

3.6 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes.

B. Install freestanding hose connections for access and minimum passage restriction.

C. Install NPS 1-1/2 hose-connection valves with flow-restricting device.

D. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

3.7 HOSE-STATION INSTALLATION

A. Install freestanding hose stations for access and minimum passage restriction.

B. Install NPS 1-1/2 hose-station valves with flow-restricting device unless otherwise indicated.

C. Install freestanding hose stations with support or bracket attached to standpipe.

D. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

E. Install hose-reel hose stations on wall with bracket.

3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type fire-department connections.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

1. Install two protective pipe bollards on sides of each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."

C. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.9 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 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 standpipe systems according to NFPA 14, "System Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, Schedule 40, steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Wet-type fire-suppression standpipe piping, NPS 4 and smaller, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 5 to NPS 8, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. 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.

END OF SECTION 211200

SECTION 211213

FIRE-SUPPRESSION HOSES AND NOZZLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. NPS 1-1/2 rack-type hose stations.
2. NPS 1-1/2 reel-type hose stations.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets" for hose cabinets.
2. Section 211200 "Fire-Suppression Standpipes" for fire hose valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 NPS 1-1/2 RACK-TYPE HOSE STATIONS

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

1. Potter Roemer LLC; a Division of Morris Group International.
2. Viking Corporation.

B. Hose Rack:

1. Standard: UL 47.
2. Material: Brass or bronze with polished chrome-plated finish.
3. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.

4. Operation: Semiautomatic.
5. Sized to hold fire hose.

C. Hose Valve:

1. Standard: UL 668, NPS 1-1/2, for connecting fire hose.
2. Type: Adjustable.
3. Pressure-Control Device: Not required.
4. Hose Valve and Trim Finish: Polished chrome-plated.
5. Pressure Rating: 300 psig minimum.
6. Pattern: Angle.
7. Material: Brass or bronze.
8. Pressure-Control Device: UL 1468 integral or for field installation if indicated.
9. Size: NPS 1-1/2.
10. Inlet: Female pipe threads.
11. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.

D. Hose:

1. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
2. Size: NPS 1-1/2.
3. Length: 100 feet.
4. Jacket: Combination of natural and synthetic threads.
5. Lining: Rubber, plastic, or combination of rubber and plastic compounds.
6. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
7. Nozzle: UL 401.

    a. Material: Brass.
    b. Type: Plain, for nonadjustable water stream.

2.2 NPS 1-1/2 REEL-TYPE HOSE STATIONS

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

1. American Fire Hose & Cabinet.
2. Potter Roemer LLC; a Division of Morris Group International.

B. Hose Reel:

1. Standard: UL 47.
2. Hose Reel and Bracket Material: Steel.
3. Type: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
4. Operation: Semiautomatic.
5. Sized to hold fire hose.
6. Finish: Red enamel.

C. Hose Valve:

1. Standard: UL 668, NPS 1-1/2, for connecting fire hose.

2. Type: Adjustable.
3. Pressure-Control Device: Not required.
4. Hose Valve and Trim Finish: Polished chrome-plated.
5. Pressure Rating: 300 psig minimum.
6. Pattern: Angle.
7. Material: Brass or bronze.
8. Pressure-Control Device: UL 1468, integral or for field installation if indicated.
9. Size: NPS 1-1/2.
10. Inlet: Female pipe threads.
11. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.

D. Hose:

1. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
2. Size: NPS 1-1/2.
3. Length: 100 feet.
4. Jacket: Combination of natural and synthetic threads.
5. Lining: Rubber, plastic, or combination of rubber and plastic compounds.
6. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
7. Nozzle: UL 401.

a. Material: Brass.
b. Type: Spray, adjustable from shutoff to fog spray or straight stream.

PART 3 - EXECUTION

3.1 HOSE-STATION INSTALLATION

A. Install freestanding hose stations for access and minimum passage restriction.

B. Install NPS 1-1/2 hose-station valves with flow-restricting device unless otherwise indicated.

C. Install freestanding hose stations with support or bracket attached to standpipe.

D. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

E. Install hose-reel hose stations on wall with bracket.

END OF SECTION 211213

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SECTION 211313

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Manual control stations.
6. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For wet-pipe 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. Submit all calculations and plans to the local authority having jurisdiction for approval. Make all changes necessary to obtain approval. Then submit to the engineer for record keeping.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which items of other systems and equipment are shown and coordinated with each other, using input from installers of the items involved.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. 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."

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

1. NFPA 13.
2. NFPA 13R.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: 3/2/2016.
b. Time: 2:40 p.m.
c. Location of Residual Fire Hydrant R: Anderson Hill Road.
d. Location of Flow Fire Hydrant F: Anderson Hill Road.
e. Static Pressure at Residual Fire Hydrant R: 87 psig
f. Measured Flow at Flow Fire Hydrant F: 1801 gpm
g. Residual Pressure at Residual Fire Hydrant R: 78 psig

2. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:

1) Automobile Parking Areas: Ordinary Hazard, Group 1.
2) Building Service Areas: Ordinary Hazard, Group 1.
3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
4) General Storage Areas: Ordinary Hazard, Group 1.
5) Laundries: Ordinary Hazard, Group 1.
6) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
7) Office and Public Areas: Light Hazard.
8) Residential Living Areas: Light Hazard.
9) Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.

4. Maximum Protection Area per Sprinkler: According to UL listing.
5. Maximum Protection Area per Sprinkler:

   a. Residential Areas: 200 sq. ft.
   b. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Galvanized-Steel Pipe: ASTM A 135/A 135M; 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. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized-Steel Couplings: ASTM A 865/A 865M, threaded.

E. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.

   a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
   b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

I. Grooved-Joint, Steel-Pipe Appurtenances:

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

    a. Anvil International.
    b. National Fittings, Inc.
    c. Victaulic Company.

2. Pressure Rating: 175-psig minimum.
3. Galvanized 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.

J. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

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

    a. Victaulic Company.

2.3 COVER SYSTEM FOR SPRINKLER PIPING

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

1. DecoShield Systems, Inc.

B. Description: System of support brackets and covers made to protect sprinkler piping.

C. Brackets: Glass-reinforced nylon.

D. Covers: Extruded-PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.4 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Specialty Valves Pressure Rating: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:

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

    a. Reliable Automatic Sprinkler Co., Inc. (The).
    b. Tyco by Johnson Controls Company.
    c. Victaulic Company.

2. Standard: UL 193.

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

G. Automatic (Ball Drip) Drain Valves:

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

    a. Reliable Automatic Sprinkler Co., Inc. (The).
    b. Tyco by Johnson Controls Company.

2. Standard: UL 1726.

3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

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

    a. Anvil International.
    b. Tyco by Johnson Controls Company.
    c. 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-tee 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. Flow Detection and Test Assemblies:

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

    a. Reliable Automatic Sprinkler Co., Inc. (The).
    b. Tyco by Johnson Controls Company.
    c. Victaulic Company.

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

C. Branch Line Testers:

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

    a. AGF Manufacturing, Inc.
    b. Elkhart Brass Mfg. Co., Inc.
    c. Fire-End & Croker Corporation.

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

D. Sprinkler Inspector's Test Fittings:

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

    a. Tyco by Johnson Controls Company.
    b. Victaulic Company.
    c. Viking Corporation.

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

E. Adjustable Drop Nipples:

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

a. Aegis Technologies, Inc.
b. Merit Manufacturing.

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.

2.6 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc. (The).
2. Victaulic Company.
3. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Automatic Sprinklers with Heat-Responsive Element:
1. Nonresidential Applications: UL 199.
2. Residential Applications: UL 1626.
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.

F. Sprinkler Finishes: Chrome plated.

G. Special Coatings: Wax and corrosion-resistant paint.

H. 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.

I. Sprinkler Guards:

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

a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco by Johnson Controls Company.
c. Victaulic Company.

2. Standard: UL 199.

3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 MANUAL CONTROL STATIONS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.

B. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.8 PRESSURE GAGES

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

1. WIKA Instrument Corporation.

B. Standard: UL 393.

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

D. Pressure Gage Range: 0- to 250-psig minimum.

E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

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

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

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

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to 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. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

N. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices.

O. Fill sprinkler system piping with water.

P. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

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

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

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

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

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

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

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, 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.

I. 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.

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

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

3.4 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

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

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.6 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.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 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 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 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

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

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright sprinklers.

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

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.

5. Upright, Pendent, and, Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

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SECTION 211316 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinkler specialty pipe fittings.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For dry-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For dry-pipe 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. The capacity of the air compressor(s) shall be the responsibility of the contractor. Submit all calculations and plans to the local authority having jurisdiction for approval. Make all changes necessary to obtain approval. Then submit to the engineer for record keeping.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which items of other systems and equipment are shown and coordinated with each other, using input from installers of the items involved.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. 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."

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 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.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

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

2.2 PERFORMANCE REQUIREMENTS

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

1. NFPA 13.
2. NFPA 13R.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design dry-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: 3/2/2016.
b. Time: 2:40 p.m.
c. Location of Residual Fire Hydrant R: Anderson Hill Road.
d. Location of Flow Fire Hydrant F: Anderson Hill Road.
e. Static Pressure at Residual Fire Hydrant R: 87 psig
f. Measured Flow at Flow Fire Hydrant F: 1801 gpm

g. Residual Pressure at Residual Fire Hydrant R: 78 psig

D. 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. Automobile Parking Areas: Ordinary Hazard, Group 1.
b. Building Service Areas: Ordinary Hazard, Group 1.
c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
d. General Storage Areas: Ordinary Hazard, Group 1.
e. Laundries: Ordinary Hazard, Group 1.
f. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
g. Office and Public Areas: Light Hazard.
h. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.

4. Maximum Protection Area per Sprinkler: According to UL listing.
5. Maximum Protection Area per Sprinkler:

a. Attic Spaces: 200 sq. ft.
b. Garage Areas: 200 sq. ft..
c. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.3 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Galvanized-Steel Pipe: ASTM A 135/A 135M; 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. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized-Steel Couplings: ASTM A 865/A 865M, threaded.

E. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME B16.1, Class 125.

H. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.

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

a. Anvil International.

I. Grooved-Joint, Steel-Pipe Appurtenances:

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

a. Tyco by Johnson Controls Company.
b. Victaulic Company.

2. Pressure Rating: 175-psig minimum.

3. Galvanized, 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.

2.4 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Specialty Valves Pressure Rating: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Dry-Pipe Valves:

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

a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco by Johnson Controls Company.
c. Victaulic Company.

2. Standard: UL 260.

3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air-Pressure Maintenance Device:

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

        1) Reliable Automatic Sprinkler Co., Inc. (The).
        2) Tyco by Johnson Controls Company.
        3) Victaulic Company.

    b. Standard: UL 260.

    c. Type: Automatic device to maintain minimum air pressure in piping.
    d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.

6. Air Compressor:

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

        1) General Air Products, Inc.
        2) Viking Corporation.

    b. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
    c. Motor Horsepower: Fractional.
    d. Power: 120-V ac, 60 Hz, single phase.

G. Automatic (Ball Drip) Drain Valves:

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

    a. Reliable Automatic Sprinkler Co., Inc. (The).
    b. Tyco by Johnson Controls Company.

2. Standard: UL 1726.

3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.5 SPRINKLER PIPING SPECIALTIES

A. General Requirements for Dry-Pipe System Fittings: UL listed for dry-pipe service.

B. Branch Outlet Fittings:

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

   a. Tyco by Johnson Controls Company.
   b. 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-tee 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.

C. Flow Detection and Test Assemblies:

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

   a. Reliable Automatic Sprinkler Co., Inc. (The).
   b. Tyco by Johnson Controls Company.
   c. Victaulic Company.

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

D. Branch Line Testers:

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

   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Roemer LLC; a Division of Morris Group International.

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

E. Sprinkler Inspector's Test Fittings:

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

   a. Tyco by Johnson Controls Company.
   b. Victaulic Company.
   c. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

F. Adjustable Drop Nipples:

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

   a. Merit Manufacturing.

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

2.6 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc. (The).
2. Victaulic Company.
3. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

F. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Residential Applications: UL 1626.

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.

G. Sprinkler Finishes: Chrome plated.

H. Special Coatings: Wax and corrosion-resistant paint.

I. 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.

J. Sprinkler Guards:

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

a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco by Johnson Controls Company.
c. Victaulic Company.

2. Standard: UL 199.

3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 MANUAL CONTROL STATIONS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.

B. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.8 PRESSURE GAGES

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

1. WIKA Instrument Corporation.

B. Standard: UL 393.

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

D. Pressure Gage Range: 0- to 250-psig minimum.

E. Label: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

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

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

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

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.

K. Connect compressed-air supply to dry-pipe sprinkler piping.

L. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.
2. Electrical power system.
3. Fire-alarm devices, including low-pressure alarm.

M. Install alarm devices in piping systems.

N. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

P. Drain dry-pipe sprinkler piping.

Q. Pressurize and check dry-pipe sprinkler system piping and air compressors.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

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

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

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

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

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

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

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

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

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install dry-pipe valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

    a. Install air compressor and compressed-air-supply piping.
    b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
    c. Install compressed-air-supply piping from building's compressed-air piping system.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following 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. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 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 joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, dry-pipe sprinkler system, NPS 2 and smaller, shall be[**one of**] the following:

1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be[**one of**] the following:

1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.10 SPRINKLER SCHEDULE

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

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Dry concealed sprinklers.
3. Wall Mounting: Dry sidewall sprinklers.
4. Spaces Subject to Freezing: Upright sprinklers.

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

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211316

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SECTION 213113 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. In-line fire pumps.
   2. Fire-pump accessories and specialties.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.

   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: Installer's responsibilities include determining when fire pumps are needed based on hydraulically calculated flow analysis using the highest system demand, including standpipe demand. The capacity of the fire pump(s) shall be the responsibility of the contractor. The fire pump design shall comply with the latest version of the applicable NFPA standards and all other applicable state and local codes. Submit all calculations and plans to the local authority having jurisdiction for approval. Make all changes necessary to obtain approval. Then submit to the engineer for record keeping.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 20.

B. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

C. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

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

2.2 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

A. Description: Factory-assembled and -tested fire-pump and driver unit.

B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.3 IN-LINE FIRE PUMPS

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

1. A-C Fire Pump; a Xylem brand.
2. S.A. Armstrong Limited.

B. Pump:

1. Standard: UL 448, for in-line pumps for fire service.
2. Casing: Radially split case, cast iron, with ASME B16.1 pipe-flange connections.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.

    a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
    b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base. Motor and pump rotating assembly shall be removable from top without removing the pump casing from the piping.

C. Coupling: None or rigid.

D. Driver:

1. Standard: UL 1004A.
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:

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

a. WATTS.
b. Zurn Industries, LLC.

2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Discharge Cone: Closed or open type.

G. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel, with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.
5. Manifold:

a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe, with ends threaded according to ASME B1.20.1.
d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
e. Escutcheon Plate: Brass or bronze; rectangular.
f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
g. Exposed Parts Finish: Polished brass.
h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

6. Manifold:

a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
c. Escutcheon Plate: Brass or bronze; round.

d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
e. Exposed Parts Finish: Polished brass.
f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.5 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1. Verification of Performance: Rate fire pumps according to UL 448.

B. Fire pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately, so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211200 "Fire-Suppression Standpipes." and Section 211313 "Wet-Pipe Sprinkler Systems."

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Section 211200 "Fire-Suppression Standpipes." and Section 211313 "Wet-Pipe Sprinkler Systems."

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.2 ALIGNMENT

A. Align end-suction pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.3 CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211200 "Fire-Suppression Standpipes." and Section 211313 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.5 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 2623933 "Controllers for Fire-Pump Drivers."

B. Perform the following tests and inspections.

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test according to NFPA 20 for acceptance and performance testing.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

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

END OF SECTION 213113

SPECIFICATIONS GROUP

Facility Services Subgroup

DIVISION 22 - PLUMBING

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SECTION 22 00 00

PLUMBING SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 22, and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Work covered under Plumbing contract.
2. Work under other contracts.
3. Use of premises.
4. Owner's occupancy requirements.
5. Specification formats and conventions.

B. Related Sections include the following:

1. Division 22 Sections.

1.3 WORK COVERED UNDER PLUMBING CONTRACT

A. Provide all labor, materials, tools, machinery, equipment, and services necessary to complete the plumbing work under this contract. All systems and equipment shall be complete in every respect and all items of material, equipment, and labor shall be provided for a fully operational system. Coordinate the work with work of other trades so as to resolve conflicts without impeding job progress. The plumbing work includes the following:

B. The plumbing contractor shall furnish all labor, materials, equipment, rigging, appliances, tools and accessories required for providing, installing, connecting and testing the new plumbing system, associated work, controls etc., in accordance with these specifications and the applicable drawings. The work includes:

1. Furnish and install new domestic hot water heaters as indicated on plumbing drawings complete with wall mounted support/drain pan, hot and cold water piping, drain piping, valves, gauges, insulation, electricals, controls, gas piping (where indicated) circulator pumps, supports, identification tags, and connection to existing system for a complete operating system.

2. Furnish and install hot and cold domestic water piping with domestic hot water return piping.

3. Furnish and install new drain, waste, and vent pipes and floor drains. Coordinate all slopes and inverts.

4. Furnish and install new storm and emergency overflow storm piping. Coordinate all slopes and inverts.

5. Furnish and install new plumbing fixtures, valves, strainers, cleanouts, accessories, etc. as specified on the drawings and in the specifications.

6. Provide new gas lines to all gas fired HV/HVAC equipment, water heaters, kitchen equipment, etc. as called out on the drawings. Coordinate installation with local gas company. Contractor to arrange with local gas company to bring new gas service to the building. Pay for all permits and fees.

7. Provide insulation for all domestic cold water, domestic hot water, domestic hot water return, storm piping, and roof drain pans. Insulation shall be continuous for the entire length of the pipe and provided with high density insulation at hangers and supports with shields at hangers.

8. Provide identification tags for all piping.

9. Provide proper piping supports, hangers, anchors, spring isolation hangers, etc.

10. Provide proper slope to all piping as per National Standard Plumbing Code and other applicable codes.

11. Pressure test all piping for any leakage. Provide pressure test reports (six (6) copies) to the Owner/Architect for review.

12. Paint all non-insulated piping. New exterior gas piping shall be painted yellow.

13. Provide backflow preventers, shut-off valves, pressure reducing valves, relief valves, etc. for cold water piping connections to heating equipment as per local building codes.

14. Provide gas pressure regulators for all appliances and heating equipment connected to gas piping.

1.4 WORK UNDER OTHER CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.5 USE OF PREMISES

A. General: Each Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Owner Occupancy: Allow for Owner occupancy of Project site and use by the public.

2. Driveways and Entrances: Keep driveways parking garage, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

   a. Schedule deliveries to minimize use of driveways and entrances.
   b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of Existing Building: Maintain existing building in a weather tight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

1.6 OWNER'S OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction.

B. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.

2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

C. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.

2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.

3. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed.

1.7 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI/CSC's "MasterFormat" numbering system.

1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.

2. Division 1: Sections in Division 1 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

1.8 MISCELLANEOUS PROVISIONS

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 22 00 00

SECTION 22 05 01

BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Mechanical demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Supports and anchorages.

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.

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

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

F. The following are industry abbreviations for plastic materials:

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

G. The following are industry abbreviations for rubber materials:

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

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPE, TUBE, AND FITTINGS

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

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

2.3 JOINING MATERIALS

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

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

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

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

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

2.4 DIELECTRIC FITTINGS

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

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

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

1. Manufacturers:
   a. Eclipse, Inc.
   b. Epco Sales, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Zurn Industries, Inc.; Wilkins Div.

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

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Epco Sales, Inc.
   c. Watts Industries, Inc.; Water Products Div.

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

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

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

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

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

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.

2.5 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel or Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

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

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

1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

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

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

C. One-Piece/Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

D. One-Piece/Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

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

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

2.8 GROUT

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

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

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

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

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

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

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

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

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

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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

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

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

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

R. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

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

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

3.3 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

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

3.5 PAINTING

A. Painting of mechanical systems, equipment, and components is specified.

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

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

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

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

3.8 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout around anchors.

G. Cure placed grout.

END OF SECTION 22 05 01

SECTION 22 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. PVC sleeves in first paragraph below may be prohibited by fire authorities having jurisdiction.

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

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) 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. PVC sleeves in paragraph below may be prohibited by fire authorities having jurisdiction.

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.

B. 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.

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

C. Pressure Plates: Stainless steel.

D. 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 (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

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

D. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

E. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

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

G. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

H. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

I. Install sleeves for pipes passing through interior partitions.

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

K. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

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

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

3.2 STACK-SLEEVE-FITTING INSTALLATION

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

B. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

C. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

E. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

F. Using grout, seal the space around outside of stack-sleeve fittings.

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

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.
D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

B. Exterior Concrete Walls above Grade:

1. Piping Smaller Than NPS 6: Cast-iron wall sleeves
2. Piping NPS 6 and Larger: Cast-iron wall sleeves.

C. Exterior Concrete Walls below Grade:

1. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system
2. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
3. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
4. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

D. Concrete Slabs-on-Grade:

1. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
2. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
3. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
4. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

E. Concrete Slabs above Grade:

1. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
2. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

F. Interior Partitions:

1. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
2. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

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

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

C. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
2. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
3. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
5. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
6. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
7. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
8. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
9. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
10. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
11. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped steel type with concealed hinge.

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

E. 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 22 05 18

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

B. Related Sections:

1. Section 221116 "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 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch (127-mm) nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg. F.

E. Connector Type(s): Union joint, adjustable angle or rigid, with unified-inch screw threads.

F. Connector Size: 1/2 inch (13 mm) with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

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

1. Standard: ASME B40.200.
2. Case: Cast aluminum, 6-inch (152-mm) nominal size.
3. Case Form: Back angle or Straight unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue [or red] organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg. F.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum, 9-inch (229-mm) nominal size unless otherwise indicated.
3. Case Form: Adjustable angle, Back angle or Straight unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg. F.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 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] <Insert material>.
4. Material for Use with Steel Piping: [CRES] [CSA] <Insert material>.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.4 PRESSURE GAGES

A. Manufacturers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

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

1. Standard: ASME B40.100.
2. Case: [Liquid-filled] [Sealed] [Open-front, pressure relief] [Solid-front, pressure relief] type(s); cast aluminum; 4-1/2-inch (114-mm) nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

4. Pressure Connection: Brass, with [NPS 1/4 (DN 8)] [NPS 1/4 or NPS 1/2 (DN 8 or DN 15)] [NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled, Sealed type; cast aluminum; 4-1/2-inch (114-mm) nominal diameter with [back] [front] flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with [NPS 1/4 (DN 8)] [NPS 1/4 or NPS 1/2 (DN 8 or DN 15)] [NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with [NPS 1/4 (DN 8)] [NPS 1/4 or NPS 1/2 (DN 8 or DN 15)] [NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and [piston] [porous-metal]-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with [NPS 1/4 (DN 8)] [NPS 1/4 or NPS 1/2 (DN 8 or DN 15)] [NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: [NPS 1/4 (DN 8)] [or] [NPS 1/2 (DN 15)], ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending [a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

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

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

L. Install pressure gages in the following locations:

1. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Liquid-filled or Sealed, bimetallic-actuated type.
2. Industrial]-style, liquid-in-glass type.
3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

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

3.5 THERMOMETER SCALE-RANGE SCHEDULE

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

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).

C. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

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

D. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

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

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 200 psi (0 to 1400 kPa).

B. Scale Range for Domestic Water Piping: 0 to 200 psi (0 to 1400 kPa).

END OF SECTION 22 05 19

SECTION 22 05 23

VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following general-duty valves (Lead Free Type):

1. Copper-alloy ball valves.
2. Ferrous-alloy ball valves.
3. Bronze check valves.
4. Ferrous-alloy wafer check valves.
5. Spring-loaded, lift-disc check valves.
6. Bronze gate valves.
7. Bronze globe valves.

B. Related Sections include the following:

1. Division 22 Section for valve tags and charts.
2. Division 22 piping Sections for specialty valves applicable to those Sections only.

C. All valves and fittings for portable water system shall be lead-free type in compliant with requirements of NSF/ANSI Standard 61.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions;

and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 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 hand-wheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze/Brass Valves: NPS 2 (DN 50) and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 (DN 65) and larger with flanged ends, unless otherwise indicated.

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

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chain wheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive: For quarter-turn valves NPS 8 (DN 200) and larger.
3. Hand wheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 (DN 150) and smaller, except plug valves.
5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Solder Joint: With sockets according to ASME B16.18.
   a. Caution: Use solder with melting point below 840 deg F (454 deg C) for angle, check, gate, and globe valves; below 421 deg F (216 deg C) for ball valves.
2. Threaded: With threads according to ASME B1.20.1.

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

2.3 COPPER-ALLOY BALL VALVES

A. Available Manufacturers:

B. Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Grinnell Corporation.
   d. Kitz Corporation of America.
   e. Legend Valve & Fitting, Inc.
   f. NIBCO INC.

g. Watts Industries, Inc.; Water Products Div.

C. Copper-Alloy Ball Valves, General: MSS SP-110, full port type.

D. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, full port type.

2.4 FERROUS-ALLOY BALL VALVES

A. Available Manufacturers:

B. Manufacturers:

1. American Valve, Inc.
2. Conbraco Industries, Inc.; Apollo Div.
3. Cooper Cameron Corp.; Cooper Cameron Valves Div.
4. Flow-Tek, Inc.
5. Hammond Valve.
6. Kitz Corporation of America.
7. KTM Products, Inc.
8. Milwaukee Valve Company.
9. NIBCO INC.
10. Richards Industries; Marwin Ball Valves.

C. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends, full port.

D. Ferrous-Alloy Ball Valves: Class 150, full port.

2.5 BRONZE CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Bronze, Horizontal Lift Check Valves with Metal Disc:
   a. Cincinnati Valve Co.
   b. Red-White Valve Corp.
   c. Walworth Co.
2. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:
   a. Cincinnati Valve Co.
   b. Red-White Valve Corp.
   c. NIBCO INC.
3. Type 3, Bronze, Swing Check Valves with Metal Disc:
   a. American Valve, Inc.
   b. Cincinnati Valve Co.
   c. Grinnell Corporation.
   d. Hammond Valve.
   e. Kitz Corporation of America.
   f. Legend Valve & Fitting, Inc.
   g. Milwaukee Valve Company.

h. NIBCO INC.
i. Powell, Wm. Co.
j. Red-White Valve Corp.
k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.

C. Bronze Check Valves, General: MSS SP-80.

D. Type 1, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

E. Type 1, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

F. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

2.6 FERROUS-ALLOY WAFER CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Dual-Plate, Ferrous-Alloy, Wafer-Lug Check Valves:
   a. Gulf Valve Co.
   b. Valve and Primer Corp.
   c. NIBCO INC.
2. Dual-Plate, Ferrous-Alloy, Double-Flanged-Type Check Valves:
   a. Gulf Valve Co.
   b. Techno Corp.
   c. NIBCO INC.

C. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.

D. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Double-Flanged Check Valves: Flanged-end body.

2.7 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type I, Wafer Lift-Disc Check Valves:
   a. Mueller Steam Specialty.
2. Type II, Compact-Wafer, Lift-Disc Check Valves:
   a. Durabla Fluid Technology, Inc.
   b. Flomatic Valves.
   c. Grinnell Corporation.
   d. Hammond Valve.
   e. Metraflex Co.
   f. Milwaukee Valve Company.

g. Mueller Steam Specialty.
h. NIBCO INC.

3. Type III, Globe Lift-Disc Check Valves:
   a. Durabla Fluid Technology, Inc.
   b. GA Industries, Inc.
   c. Grinnell Corporation.
   d. Hammond Valve.
   e. Metraflex Co.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
4. Type IV, Threaded Lift-Disc Check Valves:
   a. Check-All Valve Mfg. Co.
   b. Durabla Fluid Technology, Inc.
   c. Grinnell Corporation.
   d. Legend Valve & Fitting, Inc.
   e. Metraflex Co.
   f. Milwaukee Valve Company.
   g. Mueller Steam Specialty.
   h. NIBCO INC.
   i. Watts Industries, Inc.; Water Products Div.

C. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

D. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

E. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

F. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

G. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

2.8 BRONZE GATE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Bronze, Non-Rising-Stem Gate Valves:
   a. American Valve, Inc.
   b. Cincinnati Valve Co.
   c. Grinnell Corporation.
   d. Hammond Valve.
   e. Kitz Corporation of America.
   f. Legend Valve & Fitting, Inc.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell, Wm. Co.

j. Red-White Valve Corp.
k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.

2. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:
   a. American Valve, Inc.
   b. Cincinnati Valve Co.
   c. Grinnell Corporation.
   d. Hammond Valve.
   e. Kitz Corporation of America.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Powell, Wm. Co.
   i. Red-White Valve Corp.
   j. Walworth Co.

C. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy hand wheel.

D. Type 1, Class 150, Bronze Gate Valves: Bronze body with non-rising stem and bronze solid wedge and union-ring bonnet.

E. Type 2, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge and union-ring bonnet.

2.9 BRONZE GLOBE VALVES

A. Available Manufacturers:

B. Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:
   a. Cincinnati Valve Co.
   b. Grinnell Corporation.
   c. Hammond Valve.
   d. Kitz Corporation of America.
   e. Legend Valve & Fitting, Inc.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Powell, Wm. Co.
   i. Red-White Valve Corp.
   j. Walworth Co.
2. Type 2, Bronze Globe Valves with Nonmetallic Disc:
   a. Cincinnati Valve Co.
   b. Grinnell Corporation.
   c. Hammond Valve.
   d. Kitz Corporation of America.
   e. McWane, Inc.; Kennedy Valve Div.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Powell, Wm. Co.
   i. Red-White Valve Corp.
   j. Walworth Co.
3. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:

a. Cincinnati Valve Co.
b. Grinnell Corporation.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Walworth Co.

C. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy hand wheel.

D. Type 1, Class 150, Bronze Globe Valves: Bronze body with bronze disc and union-ring bonnet.

E. Type 3, Class 150, Bronze Globe Valves: Bronze body with bronze disc and renewable seat. Include union-ring bonnet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

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

B. 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.

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

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

E. 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.

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

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or gate valves.
2. Throttling Service: Ball or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

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

C. Heating Water Piping: Use the following types of valves:
1. Ball Valves, NPS 2 (DN 50) and Smaller: One or Two-piece, CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 (DN 65) and Larger: Class 150, ferrous alloy.
3. Lift Check Valves, NPS 2 (DN 50) and Smaller: Type 2, Class 150, horizontal / vertical, bronze.
4. Swing Check Valves, NPS 2 (DN 50) and Smaller: Type 4, Class 150, bronze.
5. Swing Check Valves, NPS 2-1/2 (DN 65) and Larger: Type II, Class 125, gray iron.
6. Wafer Check Valves, NPS 2-1/2 (DN 65) and Larger: Single / Dual-plate, wafer-lug/ double-flanged, Class 150, ferrous alloy.
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2 (DN 50) and Smaller: Type IV, Class 150.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 (DN 65) and Larger: Class 125, cast iron.
9. Gate Valves, NPS 2 (DN 50) and Smaller: Type 2 / 3, Class 150, bronze.
10. Globe Valves, NPS 2 (DN 50) and Smaller: Type 2, Class 150, bronze.

3.3 VALVE INSTALLATION

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

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

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

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

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

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 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.

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. Equipment supports.

B. Related Sections:

1. Section 230548 "Mechanical Vibration and Seismic Controls" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 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.

C. Provide hangers and supports with insulation shields in order to keep insulation fully in-tact.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.
5. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Fiberglass strut systems. Include Product Data for components.
4. Pipe stands. Include Product Data for components.
5. Equipment supports.
6. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

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: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Manufacturers' catalogs indicate that copper pipe hangers are small, typically NPS 4 (DN 100) or smaller, and types available are limited.

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

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688 kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or [ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

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

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

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

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

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel 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: Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
5. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 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, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 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.

C. 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.

D. 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.

E. Metal framing system in first paragraph below requires calculating and detailing at each use.

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

G. Fiberglass strut system in first paragraph below requires calculating and detailing at each use.

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

I. Fastener System Installation:

1. Verify suitability of fasteners in two subparagraphs below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
2. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

J. Pipe stand in first paragraph below requires calculating and detailing at each use.

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

L. Equipment support in first paragraph below requires calculating and detailing at each use.

M. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. 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.
3. Install lateral bracing with pipe hangers and supports to prevent swaying.
4. Install building attachments within concrete slabs or attach to structural steel.
5. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [NPS 2-1/2 (DN 65)] <Insert size> and larger and at changes in direction of piping.
6. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts

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

O. 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.

P. Insulated Piping:

1. Attach clamps and spacers to piping.
2. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
3. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
4. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
5. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated.
6. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

7. High-compressive-strength inserts may permit use of shorter shields or shields with less arc span. Revise first subparagraph below to suit Project.
8. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

Q. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
2. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
3. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
4. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

R. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

S. 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 ADJUSTING

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

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

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

C. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Interior Painting".

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

3.5 HANGER AND SUPPORT SCHEDULE

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

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

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

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

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

END OF SECTION 22 05 29

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SECTION 22 05 48

VIBRATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Restrained spring isolators.
2. Housed spring mounts.
3. Spring hangers.
4. Spring hangers with vertical-limit stops.
5. Thrust limits.
6. Pipe riser resilient supports.

B. Definitions:

1. A_v: Effective peak velocity related acceleration coefficient.

1.2 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. 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 has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
5. Details for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 VIBRATION ISOLATORS

A. Available Manufacturers:

1. Ace Mounting Co., Inc.
2. Amber/Booth Company, Inc.
3. B-Line Systems, Inc.
4. California Dynamics Corp.
5. Isolation Technology, Inc.
6. Kinetics Noise Control, Inc.
7. Mason Industries, Inc.
8. Vibration Eliminator Co., Inc.
9. Vibration Isolation Co., Inc.
10. Vibration Mountings & Controls/Korfund.

B. Restrained Elastomeric Mounts: All-directional elastomeric mountings with seismic restraint.

1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
2. Neoprene: Shock-absorbing materials compounded a as defined by AASHTO.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
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 the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

E. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel before contacting a resilient collar.

F. Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

G. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. 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.
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 the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

H. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. 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.
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 the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. 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 the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

J. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

K. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch- thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

B. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

C. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

D. Install resilient bolt isolation washers on equipment anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect isolator seismic-restraint clearance.
2. Test isolator deflection.
3. Inspect minimum snubber clearances.

B. Provide certification report to A/E.

3.3 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment 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.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust air spring leveling mechanism.

E. Adjust active height of spring isolators.

F. Adjust snubbers according to manufacturer's written recommendations.

G. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

H. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

END OF SECTION 22 05 48

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates
2. Equipment markers
3. Equipment signs
4. Access panel and door markers
5. Valve tags
6. Pipe Markers

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
   a. Manufacturer, product name, model number, and serial number.
   b. Capacity, operating and power characteristics, and essential data.
   c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data:

a. Name and plan number
b. Equipment service
c. Design capacity
d. Other design parameters such as pressure drop, entering and leaving conditions, and speed

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

1. Material: 0.032 inch-thick brass/aluminum
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters
2. Pumps and similar motor-driven units.
3. Fans.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 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.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible.
    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Meters, gages, thermometers, and similar units.
    c. Fuel-burning units, including boilers, furnaces, heaters.
    d. Pumps and similar motor-driven units.

e. Fans.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Letter Size: Minimum 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.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

D. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 non-accessible 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 markers.

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; plumbing fixture supply stops; 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:

1. Valve-Tag Size and Shape:
   a. Hot Water: 1-1/2 inches, round/square
   b. Gas: 1-1/2 inches, round/square
   c. Steam: 1-1/2 inches, round/square

3.5 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

B. Clean faces of mechanical identification devices.

END OF SECTION 22 05 53

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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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes mechanical insulation for duct, equipment, and pipe, including the following:

1. Insulation Materials:
   a. Cellular glass.
   b. Mineral fiber.
   c. Polystyrene.
2. Fire-rated insulation systems.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. FSP: Foil, scrim, polyethylene.

D. PVDC: Polyvinylidene chloride.

E. SSL: Self-sealing lap.

1.4 SUBMITTALS

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

B. Shop Drawings: Show details for the following:

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

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

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2 (DN 50).
2. Sheet Form Insulation Materials: 12 inches square.
3. Jacket Materials for Pipe: 12 inches long by NPS 2 (DN 50).
4. Sheet Jacket Materials: 12 inches square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.

E. 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.

F. Field quality-control inspection 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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 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 size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports."

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

C. Coordinate installation and testing of heat tracing.

1.8 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 MANUFACTURERS

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

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about 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 Part 2 "Factory-Applied Jackets" Article.

1. Products:
   a. Cell-U-Foam Corporation; Ultra-CUF.
   b. Pittsburgh Corning Corporation; Foamglas Super K.
2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000° Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products:
   a. Knauf Insulation; Permawick Pipe Insulation.
   b. Owens Corning; VaporWick Pipe Insulation.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied [ASJ] [FSK jacket] complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F

is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. UL tested and certified to provide a 2-hour fire rating.

1. Products:
   a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.

1. Products:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
   f. Unifrax Corporation; FyreWrap.
   g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.4 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products:
   a. Childers Products, Division of ITW; CP-97.
   b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
   c. Marathon Industries, Inc.; 290.
   d. Mon-Eco Industries, Inc.; 22-30.
   e. Vimasco Corporation; 760.

C. Cellular-Glass, Phenolic-Foam, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

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

1. Products:
a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

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

1. Products:
a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

F. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.

1. Products:
a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 97-13.

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

1. Products:
a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

H. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products:
a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

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

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products:
   a. Childers Products, Division of ITW; CP-35.
   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Products:
   a. Childers Products, Division of ITW; CP-30.
   b. Foster Products Corporation, H. B. Fuller Company; 30-35.
   c. ITW TACC, Division of Illinois Tool Works; CB-25.
   d. Marathon Industries, Inc.; 501.
   e. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products:
   a. Childers Products, Division of ITW; Encacel.
   b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
   c. Marathon Industries, Inc.; 570.
   d. Mon-Eco Industries, Inc.; 55-70.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products:
   a. Childers Products, Division of ITW; CP-10.
   b. Foster Products Corporation, H. B. Fuller Company; 35-00.
   c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
   d. Marathon Industries, Inc.; 550.

e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

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

1. Products:
   a. Childers Products, Division of ITW; CP-52.
   b. Foster Products Corporation, H. B. Fuller Company; 81-42.
   c. Marathon Industries, Inc.; 130.
   d. Mon-Eco Industries, Inc.; 11-30.
   e. Vimasco Corporation; 136.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic-Foam, and Polyisocyanurate Products:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.
2. Joint Sealants for Polystyrene Products:
   a. Childers Products, Division of ITW; CP-70.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.

d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

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

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.8 FIELD-APPLIED JACKETS

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

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Products:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

E. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.9 TAPES

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

1. Products:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches
3. Thickness: 11.5 mils
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. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.

1. Products:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. 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.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Products:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Products:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
   a. Products:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Aluminum, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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

D. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers:
   a. ACS Industries, Inc.
   b. C & F Wire.
   c. Childers Products.
   d. PABCO Metals Corporation.
   e. RPR Products, Inc.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

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

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

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

3.3 COMMON INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

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

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

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

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

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

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

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

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

3.4 PENETRATIONS

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

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

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

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

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

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

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

1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Through-Penetration Firestop Systems."

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

3.5 EQUIPMENT INSULATION INSTALLATION

A. Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
   d. Do not over compress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. 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.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.6 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

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 but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with 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.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.9 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 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.

3.10 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 UL-listed fire rating.

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

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.11 FINISHES

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

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as 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.

3.12 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. Fire-suppression piping.
2. Drainage piping located in crawl spaces.
3. Below-grade piping.
4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 3 (DN 75) and Smaller: Insulation shall be any of the following:
   a. Cellular Glass: 1-1/2 inch thick.
   b. Mineral-Fiber Pipe Insulation, Type I: 1-1/2 inch thick.
2. NPS 4 (DN 32) and Larger: Insulation shall be any of the following:
   a. Cellular Glass: 2 inches thick.

b. Mineral-Fiber Pipe Insulation, Type I: 2 inches thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 3 (DN 75) and Smaller: Insulation shall be any of the following:
   a. Cellular Glass: 1-1/2 inches thick.
   b. Mineral-Fiber Pipe Insulation, Type I: 1-1/2 inch thick.
2. NPS 4 (DN 100) and Larger: Insulation shall be any of the following:
   a. Cellular Glass: 2 inches thick.
   b. Mineral-Fiber Pipe Insulation, Type I: 2 inch thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 22 07 19

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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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes domestic water piping inside the building and 5 feet to outside of the building.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 80 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Water Samples: Specified in Part 3 "Cleaning" Article.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Types K and L (ASTM B 88M, Types A and B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 CPVC PIPING

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

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40.

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

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

2.5 PEX TUBE AND FITTINGS

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

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

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

2.6 VALVES

A. General-duty ball valves are specified in Division 22 Section "Valves."

B. Backflow preventers, strainers, and drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

PART 3 - EXECUTION

3.1 PIPE AND FITTING APPLICATIONS

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 may be used on aboveground piping, unless otherwise indicated.

C. Fitting Option: brazed joints may be used on aboveground copper tubing.

D. Under-Building-Slab, Domestic Water Piping on House Side of Water Meter, NPS 4 (DN 100) and Smaller: Soft copper tube, Type K with no fittings.

E. Aboveground Domestic Water Piping: Use the following piping materials for each size range:

1. NPS 1 (DN 25) and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. NPS 2 (DN 50): Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.2 VALVE APPLICATIONS

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 3 (DN 75) and smaller.
2. Drain Duty: Hose-end drain valves.

B. Install drain valves at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.

3.3 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

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

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Basic Mechanical Materials and Methods."

D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 22 Section "Basic Mechanical Materials and Methods."

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Mechanical Vibration and Seismic Controls."

B. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports."

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

E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

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

1. NPS 3/4 (DN 20) and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet with 1/2-inch rod.
6. NPS 6 (DN 150): 10 feet with 5/8-inch rod.

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

3.6 CONNECTIONS

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

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

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

3.7 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

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

2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 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. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

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

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

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

END OF SECTION 22 11 16

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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. Balancing valves.
2. Strainers.
3. Drain valves.
4. Air vents.
5. Hose bibbs.
6. Wall hydrants.
7. Water hammer arresters.
8. Trap-seal primer valves.
9. Trap-seal primer systems.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 80 psig, unless otherwise indicated.

1.4 SUBMITTALS

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

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

C. Field quality-control test reports.

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

1.5 QUALITY ASSURANCE

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

B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings or a comparable product by one of the following:
   a. To require a specific valve type (ball, globe, or Y-pattern globe) or a specific material (brass or bronze), verify its availability with manufacturer.
      1. Armstrong International, Inc.
      2. ITT Industries; Bell & Gossett Div.
      3. NIBCO INC.
      4. Taco, Inc.
      5. Watts Industries, Inc.; Water Products Div.
      6. Or approved equal.
3. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
4. Body: Brass or bronze,
5. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
6. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Memory-Stop Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Red-White Valve Corp.
   g. Or approved equal.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and] for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch.
6. Drain: Pipe plug or Factory-installed, hose-end drain valve.

2.3 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 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.4 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.

3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 (DN 10) or NPS 1/2 (DN 15)] minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents <Insert drawing designation if any>:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 (DN 10) minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.5 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.6 WALL HYDRANTS

A. Non-Freeze Wall Hydrants: Refer to schedule on Drawing P6.03.

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

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

1. Josam Company.
2. MIFAB, Inc.
3. Prier Products, Inc.
4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
5. Tyler Pipe; Wade Div.
6. Watts Drainage Products Inc.
7. Woodford Manufacturing Company.
8. Zurn Plumbing Products Group; Light Commercial Operation.

9. Zurn Plumbing Products Group; Specification Drainage Operation.
10. Or approved equal.

D. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.

E. Pressure Rating: 125 psig.

F. Operation: Loose key.

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

H. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).

I. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

J. Box: Deep, flush mounting with cover.

K. Box and Cover Finish: Chrome plated.

L. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

M. Nozzle and Wall-Plate Finish: Rough bronze.

N. Operating Keys(s): Two (2) with each wall hydrant.

2.7 WATER HAMMER ARRESTERS

A. Water Hammer Arresters: Refer to schedule on Drawing P6.03.

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

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

1. AMTROL, Inc.
2. Josam Company.
3. MIFAB, Inc.
4. PPP Inc.
5. Sioux Chief Manufacturing Company, Inc.
6. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
7. Tyler Pipe; Wade Div.
8. Watts Drainage Products Inc.
9. Zurn Plumbing Products Group; Specification Drainage Operation.
10. Or approved equal.

D. Standard: ASSE 1010 or PDI-WH 201.

E. Type: [Metal bellows] [Copper tube with piston].

F. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.8 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves: Refer to schedule on Drawing P6.03.

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

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

1. MIFAB, Inc.
2. PPP Inc.
3. Sioux Chief Manufacturing Company, Inc.
4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
5. Watts Industries, Inc.; Water Products Div.
6. Or approved equal.

D. Standard: ASSE 1018.

E. Pressure Rating: 125 psig minimum.

F. Body: Bronze.

G. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.

H. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.

I. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.9 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems: Refer to schedule on Drawing P6.03.

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

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

D. Basis-of-Design Product: Subject to compliance with requirements or a comparable product by one of the following:

1. PPP Inc.
2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: As needed.
8. Size Outlets: NPS 1/2 (DN 15).
9. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Revise remaining paragraphs and subparagraphs in this Article to include specific installation requirements.

C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 6 Section "Rough Carpentry."

F. Water hammer arresters in first paragraph below are best shown on water risers and details. Specifying number, size, and location here is difficult.

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

H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

I. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

J. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Outlet boxes.
2. Supply-type, trap-seal primer valves.
3. Trap-seal primer systems.

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 Division 15 Section "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each system according to authorities having jurisdiction and the device's reference standard.

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

3.5 ADJUSTING

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

B. Set field-adjustable flow set points of balancing valves.

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

END OF SECTION 22 11 19

SECTION 22 11 22

DOMESTIC WATER PRESSURE BOOSTING SYSTEMS (VFD)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Furnish and install a factory packaged and tested, variable-speed domestic water pressure boosting system including pumps, motors, controls, valves, interconnecting piping, wiring and accessories for a complete, NSF 61 and NSF 372 Certified system with UL508A Industrial Control Panel and UL QCZJ 3rd Party Package Label affixed. Manufacturer must have a Certification Number of the 3rd Party Laboratory/Agency that has completed the approval process and this must be available and currently dated upon request from the engineer.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Underwriters Laboratories Listings 508A Industrial Control Panels and QCZJ Packaged Pumping Systems (UL)

2. 2015 Edition of the International Plumbing Code (IPC)

3. 2017 Edition of the National Electric Code, Section 409.110 (NEC)

4. National Electrical Manufacturers Association (NEMA)

5. ANSI/NSF Standard 61-2018 - Drinking Water System Components - Health Effects

6. ANSI/NSF Standard 372-2016 - Lead Free Plumbing Products

1.04 QUALITY ASSURANCE

A. All equipment under this section shall be furnished completely assembled and pre-tested at simulated project site conditions in a laboratory, by a single supplier and shall be products that the manufacturer regularly engages in the production of. The supplier shall have sole responsibility for proper functioning of the system and equipment supplied. Copies of simulated factory tests must be available at the request of the owner or engineer.

B. The manufacturer of the domestic water pressure boosting system shall be responsible for compliance with all applicable codes and regulations, and be held accountable for the complete pump package. The manufacturer must maintain a closed-loop testing laboratory which is capable of pressurized suction and supply condition simulation. The test laboratory shall feature procedures detailing an unbroken chain of calibrations as required by NIST. Open atmospheric testing equipment which cannot mimic site installation conditions are not approved or acceptable.

C. Manufacturer's Qualifications: Company specializing in manufacturing the products specified in this Section with a minimum five years documented experience. The packaged system manufacturer shall have local service available provided by a trained factory authorized representative. Manufacturer shall provide proof of a minimum $2 Million liability insurance certificate for systems provided herein.

D. Assembly Qualifications: All disconnects, transformers, and control devices shall be installed to provide minimum wire bending clearances per N.E.C. All power wiring shall be a minimum THHN, stranded copper conductor with 90° C. insulation. Conductors shall be numbered and identified at all termination points. All wiring shall be installed in nylon wire ways and laced with nylon tie straps. All disconnects, transformers, controllers, control devices, selector switches, and indicator lights shall be provided with nameplates indicating their respective function and/or identification. A factory wiring schematic shall be provided inside the controller by the manufacturer. The entire assembly shall be wired and tested in accordance with the National Electrical Code (N.E.C. 2017, Section 409.110). All components shall be built to National Electrical Manufacturers Association (NEMA) standards and be Underwriters Laboratory (UL) 508A Industrial Control Panels. The entire package pumping system shall comply with Federal Regulations 29 CFR 1910.399 and certified through UL under category ULQCZJ or other accepted 3rd Party Compliance Laboratory.

E. Installer's Qualifications: The system shall be installed by a firm having minimum ten years' experience regularly engaged in the installation of variable speed domestic booster pump systems.

F. Certification shall be obtained by the manufacturer indicating that the function and performance characteristics of all products and materials have been determined by testing and ongoing surveillance by an approved third-party certification agency. Assertion of certification shall be in the form of identification in accordance with the requirements of the third-party certification agency and provided with submittal documentation to the engineer.

1.05 SUBMITTALS

A. Product Data:

1. Provide system manufacturer's literature including general assembly, pump curves showing performance characteristics with pump and system with operating point indicated, NPSH required, controls, wiring diagrams, BAS connectivity and service connections as required.

2. Code and Standards compliance.

3. Third-Party Certifications.

B. Record Documents:

1. Provide full written description of manufacturer's warranty within the submittals.

2. Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and installation recommendations.

3. Manufacturer's Installation Instruction: Indicate support details, connection requirements, and include start-up instructions for pump system.

4. Manufacturer's Certificate: Certify that pumps meet or exceed specified requirements at specified operating conditions. Submit summary and results of factory simulated-site tests performed.

5. Provide estimated kWh performance for the system and yearly energy usage. Include reports with the submittal documents. Provide owner with load profile and calculations which clearly support energy savings payback ROI in the case of an energy performance requirement.

6. Field Reports: Submit verification statement, signed by system manufacturer representative, of start-up, adjustment service and acceptance of installation. Indicate summary of field performance test, system pipe flushing and field acceptance tests performed.

C. Operation and Maintenance Data:

1. Operation Data: Include manufacturer's instructions, start-up data, and troubleshooting check lists for pumps, drivers, and controllers.

2. Maintenance Data: Include manufacturer's literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers, preventive maintenance schedule, preventive maintenance recommendations and procedures. Identify place of purchase, location and contact numbers of service depot and technical support for each product installed.

1.06 DELIVERY, STORAGE AND HANDLING

A. Accept pumps and components on Site in factory packing. Inspect for damage. Comply with manufacturers rigging and installation instructions.

B. Protect pumps and components from physical damage including effects of weather, water, humidity, construction dust (concrete/drywall/gypsum), and construction debris.

C. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.07 EXTRA MATERIALS

A. Refer to Section 01 78 46 for Maintenance Material Requirements.

1.08 WARRANTY

A. All components furnished shall be warranted for a period of 5 years from documented date of shipment.

1.09 MAINTENANCE SERVICE

A. Furnish service and maintenance of packaged system for one year from documented date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All materials that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61 and the “complete system” shall be certified as constructed. Individual component certification is not compliant.

C. Pressure ratings of pumps, pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed. Headers shall be constructed of 304 stainless steel at a minimum.

D. The Contractor shall ascertain for himself the space and access available for the installation of a factory assembled pre-packaged and tested unit. All components of the system shall be compatible and be furnished by a single source manufacturer and all electrical services and interconnecting equipment wiring must be provided for a complete assembly with a single-source, fused power disconnect and water connections.

E. The entire system shall be factory skid mounted on a minimum 304 stainless-steel structural square tube support frame, with in-shear molded rubber vibration isolators in compliance with standards as required in installation instructions published by pump manufacturer. Suction and Discharge Headers must be supported by pump skid frame to prevent piping strain on the pump casing and during system transport. No Exceptions.

F. System must meet ANSI/ASHRAE/IES 90.1, Section 10.4.2, “Energy Standard for Buildings” and have proof of compliance utilizing either remote sensor option or software logic which adjusts set point according to flow rate.

G. For isolation valve sizes 2" and smaller, valves shall be full port bronze ball valves with integral union, compliant ball and stem design. For isolation valve sizes 2.5" and larger, valves shall be epoxy coated ductile iron lever operated lug type butterfly valves with stainless steel disc and stainless steel shaft. Valves must be rated for maximum pressure service for the system and also comply with NSF 61 & 372 Drinking Water requirements.

H. Unions or flanges shall be provided for easy removal of pumps. System headers shall be sized for a velocity not exceeding 10 FPS at full flow and shall be terminated with a groove or flanged joint capable of accepting a groove coupling ANSI flange or groove flange furnished by Contractor.

I. The packaged pumping system shall include all electrical wiring between components and shall be completely flow and pressure tested for actual site conditions at the factory prior to shipment.

J. System shall be arranged such that single point connections are required for piping and electrical power supply. Multiple power connections are un-acceptable.

K. Individual pumps, motors and check valves shall be serviceable with the booster system in operation utilizing isolation valves for each pump.

L. Refer to schedules on Contract Drawings for required pump capacities and electrical characteristics.

2.02 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are acceptable provided their products meet or exceed these Specifications and the Contract drawing schedules. Equal product compliance certification must include a signed letter from the manufacturers' owner or officer indicating products are in full compliance with all aspects of this specification as written:

1. QuantumFlo

2. Approved equal to these specifications with 10-day prior approval from the Engineer and Letter of Certification.

2.03 PUMPS AND MOTORS

A. System shall include vertical or horizontal mounted stainless steel, close-coupled, end suction centrifugal pumps with NPT threaded or ANSI flanged connections. Pump features to include stainless steel casing, back pull out design, top centerline discharge and hydraulically balanced stainless steel impeller with ceramic-carbon seal minimum. Pump shall be hydro-formed for maximum efficiency with stainless steel fitted construction and a replaceable shaft sleeve and mechanical seal.

B. Motor shall be NEMA Premium Efficiency, Class F Insulated, Inverter duty, close-coupled type with a J, JM or TC type motor. Motors shall be TEFC enclosed and manufactured in accordance with NEMA standards for the voltage, frequency and phasing indicated on the pump schedule or plans.

C. Motors shall be premium efficiency in accordance with DOE June 2016 requirements. Motors shall have ball bearings and operate at 40° ambient. Each motor shall be equipped with the manufacturer's nameplate and shall have a sufficient horsepower rating to operate the pump at any point on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor. The motor shall have a service factor of 1.15 for variations in voltage and frequency.

D. Pumps and motors larger than 5 H.P. shall be mounted with rubber-in-shear isolators to reduce vibration and stress into the baseplate, machine and system piping as required.

2.04 VARIABLE FREQUENCY DRIVES

A. System shall feature variable frequency drives of the PWM design suitable for variable torque applications using any standard NEMA Design B squirrel cage induction motor. Variable frequency drives shall be sized for the maximum possible amp draw throughout the programmed sequence of pump operation.

B. Drives shall be pulse width modulated, start into a rotating load, follow signal from logic section of control panel when in auto mode and be provided with the following features:

1. Hand/off/auto switch and manual speed adjustment if auto system is inoperable.
2. Auto Drive Shutdown for electrical fault.
3. Automatic restart after power fails shutdown.
4. Complete service diagnostics with fault history log up to 6 events.

C. Keypad Operator Device including the following:

1. Backlit LCD Display.
2. Power On and Alarm/Fault Displays.

D. Operational data displays include:

1. Drive Speed [HZ]
2. Motor Torque [%]
3. Input Power [kW]
4. Current [A]
5. Elapsed Time [Hours]
6. Motor Voltage [V]

E. No electrical A-T-L (across the line) bypass shall be provided with any drive as the VFD is the only mode of pressure control.

F. Drives shall be controlled via a Master/Slave control arrangement where the controller makes all adjustments via a high-speed interface which provides for greater PID resolution and PID auto-tuning. Exceptions to this requirement must be approved via pre-approval documentation with the engineer proving their energy-efficiency to the standard set forth.

2.05 PRESSURE SENSOR/TRANSMITTER

A. Provide suction and discharge, Type 4X, stainless-steel pressure sensors/transmitters and internal separate pressure switch with integral event-logger, which provides a 4-20 mA signal output, compatible with the system controls, temperature and pressure requirements. Pressure sensor/transmitter shall have zero, span and damping devices. The transmitter shall be installed on the system suction and discharge headers and factory wired to the control circuitry. Sensor shall feature a high contrast LED readable from a 6-foot distance by maintenance personnel. When high-contrast LED transmitters are provided, other gauges or sensors are redundant and un-necessary.

2.06 SEQUENCE OF OPERATION

A. The lead pump shall run only as necessary to maintain system pressure and will be controlled automatically by means of the pressure sensor/transmitter and programmable logic controller (PLC) designed to prevent short cycling and provide sensor-less flow detection. If the lead pump is unable to maintain system pressure the lag pump(s) will be called on as required by the sensor-less flow algorithm and will operate in parallel with the lead pump until no longer necessary and be sequenced off. When one pump can handle the system demand the controls will optimize energy consumption by eliminating the lag pump from sequence. When a low or no-flow condition is reached the system shall revert to the stand-by mode if no flow is present via an intelligent flow detection algorithm, which does not raise the set pressure to charge a tank to detect low flow. These systems DO NOT require a hydro-pneumatic tank installed and thereby does not raise the system pressure set point. (See 2.08) Note: Raising system pressure to charge a tank violates ANSI/ASHRAE/IES Standard 90.1 by raising the pressure in lieu of maintaining constant system pressure.

B. An empty pipe condition is to be determined by an algorithm allowing for a slow ramp to set point to prevent system pressure shocks. The “pipe-fill” algorithm will also prevent VFD “wind-up” and pressure spikes associated with this condition.

C. The system shall employ software to detect pipe break and stop system, initiate an alarm and log the event. In the event of a sensor failure, the system shall run one pump in a semi-automatic mode allowing the building to maintain a minimum pressure until the sensor can be repaired or replaced.

D. An auto-tuning PID algorithm shall continuously monitor system pressure and maintain steady-state system pressure as demand load changes rapidly and pump moves horizontally on its plumbing-performance curve. The PID algorithms shall incorporate intelligent algorithms to start the pumps at the point of creating pressure saving energy and reducing time to set pressure upon pump call.

2.07 CONTROL PANEL

A. Logic Section - Provide, mount and wire on the skid a programmable logic controller in a NEMA 3R, splash-proof, forced-air ventilated enclosure to fully contain all VFD’s and interface the signal from the pressure sensor to the VFD's and provide a stabilized response to speed up or slow down or add pumps to meet system requirements. The controller shall provide set point adjustment, timer adjustment, PID functions (as required) and both system and controller self-diagnostics via touch screen display. The HMI Screen shall feature an LED backlight, analog resistive, IP65/NEMA 4X, 2 GB eMMC Flash memory, rated 0-55 Degrees C with alarm logging and real-time, internal clock, Intel® Atom™ E620T 333 MHz clock speed. The touch screen display/human machine interface shall include a 7” TFT WVGA, 16.7 million color, 800x480 Pixels, resistive analog display with RS232/485 ports, Optional Ethernet (OPC-UA) and USB Ports for Upload/Download of system trend data.

B. All user interface set points shall be easily accessible via a password protected display screen. The password shall be of the “rolling” type to prevent un-authorized access to factory settings. Normal system operation shall be auto-tuned to eliminate pressure hunting. Controller shall feature an (optional) USB Download connection which allows user to download trending analysis without the need for a formal BAS connection. All system data and settings shall be accessible from the display without the need to access the high-voltage controller internals. The software shall include clear alarm indications and user troubleshooting wizards to ascertain and correct all system alarms and conditions.

C. Power Section – The internally touch-safe, high voltage controller with HMI shall be factory wired and mounted on a structural square-tube frame, stainless steel system skid. The panel shall be furnished with single-point power connection, fused main disconnect switch with a single door mounted and interlocked handle, each VFD shall be protected by a fused branch compact circuit protector. Multiple power source connections are un-acceptable. A 24-volt DC power supply shall be provided for logic, sensors and fan circuitry where necessary. Controller shall feature the following minimum additional components:

1. UL 1449 Type I Surge Arrestor with active over-voltage control via MOV's (metal oxide varistors). Passive surge or lightning arrestors are not acceptable.

2. Low suction pressure shutdown circuit with auto reset and alarm logging.

3. High system pressure shutdown circuit with auto reset and alarm logging.

4. System key-logger which records all keypad entries stored in non-volatile memory. (downloadable)

5. Audible alarm with silence push button and alarm log recognition of reset.

6. Auto-alternate all pumps automatically on each stand-by cycle.

7. 24 hour pump exerciser function which runs exercises pumps to maintain seal lubrication when the pump has not been started in the previous 24 hours.

8. Auxiliary relay contacts for all alarm conditions or discreet data monitoring capability.

9. Audible and visual indication of low storage tank level, with silence push button. (when optional suction break-tank is used)

10. Elapsed time meters, system pressure, KW and other critical values, portable to system SCADA via discrete communication.

11. Pipe Break Alarm with auto-shut down and time/date alarm logging of event.

12. Table chart indicating system pressure and system KW with optional direct to USB Flash download for the most recent 1-week events, time and date stamped.

13. The system shall not require external flow meters or KW monitoring. The system will not implement speed, thermal or time delay means to detect and shut down pumps on a no demand condition as this wastes energy and provides for unnecessary run times.

14. System must feature ANSI/ASHRAE/IES Energy Standard 90.1 compliance via either a remote mounted pressure sensor or internal system logic which detects low flow and automatically adjusts set point according to piping losses at the condition with auto reset.

15. As per current NEC 2017, Section 409.110, control panel MUST have a listed minimum SCCR value, equal to or greater than the available fault current of the feeder circuit. A coordination study must be completed and furnished by the electrical designer or contractor to verify available fault current against the connected equipment.

2.08 HYDRO-PNEUMATIC TANK (NOT REQUIRED WITH SENSOR-LESS FLOW DETECTION)

A. If required for Low Flow Detection, provide a vertical hydro-pneumatic tank with a carbon steel shell and a replaceable FDA and NSF 61/372 approved heavy-duty bladder to separate the air and water. No water shall come in contact with the metal walls of the tank. Features shall include an air fill valve, pressure gauge connection and top system connection suitable for 100 percent drawdown.

B. The tank shall be constructed in accordance with Section VIII of the ASME code and be National Board stamped and shall be rated for minimum 125 psig operating pressure and maximum operating temperature of 240 degrees F.

C. Tank shall be factory finished in high quality epoxy or enamel paint.

D. Systems which utilize sensor-less flow detection logic which does not raise system pressure to detect flow DO NOT REQUIRE the use of a tank and are allowed to be provided less this component.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install the system level and in accordance with manufacturer’s published recommendations.

D. Locate equipment with allowance for manufacturer's recommended clearances around unit.

E. Set entire unit on 4" high reinforced concrete equipment pad. Provide vibration isolators and bolt skid to pad. Structurally connect equipment pad to building slab to prevent movement.

F. Pipe discharge from all relief valves, drains and individual pump thermal purge protection solenoid valves, indirectly to floor drain having adequate capacity to accept discharge.

G. Provide, Type "L" copper full-size branch feed to the bladder tank (if required) with isolation valve from system distribution main as shown on the Contract Drawings.

3.02 FACTORY TESTING

A. The booster system shall be completely performance tested under project site simulated conditions and shall undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. The test shall be performed at the estimated site pressure conditions and pre-set to these conditions prior to shipment. Proof of simulated factory testing shall be provided to the engineer/owner. All control devices including transmitters and all safety features shall be factory calibrated and tested. Hydrostatic and/or electrical-only testing is NOT ACCEPTABLE as a compliant factory flow test.

3.03 VERIFICATION AND TESTING

A. Verify that the pumps and prime movers have been aligned according to manufacturers' recommendations.

B. Test the system performance by verifying the operation of the pumps and system vs. the pump curves, alarms, controls, etc. Testing must include simulated site suction and discharge conditions at system flow.

C. Contractor shall inform Owner 48 hours in advance of verification and testing so that Owner's Construction and Physical Plant personnel may observe, performance verifications, verification of site conditions and testing of system performance, alarms and controls.

3.04 INSTRUCTIONS AND START-UP

A. Provide for the service of a certified, factory-trained supervising agent from the pump package manufacturer to inspect the completed installation, start the system and acquaint the operators with the proper operation and maintenance of the equipment.

END OF SECTION 22 11 22

SECTION 22 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fuel gas piping within the building. Products include the following:

1. Pipe, tube, fittings, and joining materials.
2. Protective pipe and fitting coating.
3. Piping specialties.
4. Specialty valves.
5. Pressure regulators.

1.3 PROJECT CONDITIONS

A. Gas System Pressures: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2.0 psig and is reduced to secondary pressure of 0.5 psig or less.

B. Design values of fuel gas supplied for these systems are as follows:

1. Nominal Heating Value: 1000 Btu/cu. ft.
2. Nominal Specific Gravity: 0.6.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

B. Shop Drawings: For fuel gas piping. Include plans and attachments to other work.

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

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For natural gas specialties and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Electrical Components and Devices: 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. NFPA Standard: Comply with NFPA 54, "International Fuel Gas Code."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.4 PROTECTIVE COATING

A. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in contact with materials that may corrode the pipe.

2.5 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

2.6 SPECIALTY VALVES

A. Valves, NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and CSA International listed.

1. Manufacturers:
   a. American Valve Inc.
   b. B&K Industries, Inc.
   c. Brass Craft Manufacturing Co.
   d. Cimberio Valves, S. p. A.
   e. Conbraco Industries, Inc.; Apollo Div.
   f. E. M. Plastic and Electric Products, Ltd.; Neo Valve Div.
   g. JMF Company.
   h. Jomar International Ltd.
   i. Key Gas Components, Inc.
   j. Legend Valve and Fitting, Inc.

k. McDonald, A. Y. Mfg. Co.
l. Mueller Co.; Mueller Gas Products Div.
m. Newman Hattersley Ltd.; Specialty Valves Div.
n. Robert Manufacturing Co.
o. State Metals, Inc.
p. Watts Industries, Inc.; Water Products Div.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 (DN 50) and Smaller: ASME B16.33 and CSA International-listed bronze body and 125-psig pressure rating.

1. Manufacturers:
   a. BMI Canada, Inc.
   b. Crane Valves.
   c. Dungs, Karl, Inc.
   d. Flow Control Equipment, Inc.
   e. Grinnell Corp.
   f. Honeywell International Inc.
   g. Jomar International Ltd.
   h. KITZ Corporation.
   i. Legend Valve and Fitting, Inc.
   j. Lyall, R. W. & Co., Inc.
   k. McDonald, A. Y. Mfg. Co.
   l. Milwaukee Valve Company.
   m. Mueller Co.; Mueller Gas Products Div.
   n. NIBCO INC.
   o. Red-White Valve Corp.
   p. Velan Inc.
   q. Watts Industries, Inc.; Water Products Div.
2. Tamperproof Feature: Include design for locking.

F. Plug Valves, NPS 2-1/2 (DN 65) and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

1. Manufacturers:
   a. Flow Control Equipment, Inc.
   b. Milliken Valve Co., Inc.
   c. Nordstrom Valves, Inc.
   d. Olson Technologies, Inc.; Homestead Valve Div.
   e. Walworth Co.
2. Tamperproof Feature: Include design for locking.

G. General-Duty Valves, NPS 2-1/2 (DN 65) and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.

1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
2. Butterfly Valves: MSS SP-67, lug type with lever handle.

H. Automatic Gas Valves: ANSI Z21.21, with electrical/mechanical operator for actuation by appliance automatic shutoff device.

1. Manufacturers:
   a. ASCO General Controls.
   b. ASCO Power Technologies, LP; Division of Emerson.
   c. ASCO Valve Canada, Division of Emerson Electric Canada Limited.
   d. Dungs, Karl, Inc.
   e. Eaton Corporation; Controls Div.
   f. Eclipse Combustion, Inc.
   g. GPS Gas Protection Systems Inc.
   h. Honeywell International Inc.
   i. Johnson Controls.

I. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120-V ac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed.

1. Manufacturers:
   a. ASCO General Controls.
   b. ASCO Power Technologies, LP; Division of Emerson.
   c. Dungs, Karl, Inc.
   d. Eclipse Combustion, Inc.
   e. Goyen Valve Corp.; Tyco Environmental Systems.
   f. Magnatrol Valve Corp.
   g. Watts Industries, Inc.

2.7 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. Manufacturers:
   a. Service Pressure Regulators:
      1) American Meter Company.
      2) Fisher Controls International, Inc.; Division of Emerson.
      3) Invensys.
      4) National Meter Industries, Inc.
      5) Richards Industries, Inc.; Jordan Valve Div.
      6) Schlumberger Limited; Gas Div.
   b. Line Pressure Regulators:
      1) American Meter Company.
      2) Donkin, Bryan RMG Canada, Ltd.
      3) Eclipse Combustion, Inc.
      4) Fisher Controls International, Inc.; Division of Emerson.
      5) Invensys.
      6) Maxitrol Company.
      7) National Meter Industries, Inc.
      8) Richards Industries, Inc.; Jordan Valve Div.
      9) Schlumberger Limited; Gas Div.
   c. Appliance Pressure Regulators:
      1) Canadian Meter Co., Inc.
      2) Eaton Corporation; Controls Div.
      3) Harper Wyman Co.

4) Maxitrol Company.
5) SCP, Inc.

2. NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
3. NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
4. Service Pressure Regulators: ANSI Z21.80. Include 100-psig minimum inlet pressure rating.
5. Line Pressure Regulators: ANSI Z21.80 with 2-psig minimum inlet pressure rating.
6. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.
7. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.3 PIPING APPLICATIONS

A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. Fuel Gas Piping, 2 psig or Less - aboveground or in pipe tunnel:

1. NPS 3/4 to NPS 2 (DN 20 and DN 50) Steel pipe, malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 (DN 65) and Larger: Steel pipe, steel welding fittings, and welded joints.

C. Fuel Gas Piping, 2 psig or Less below slab:

1. NPS 3/4 and NPS 6 (DN 20 and DN 50) polyethylene (PE) plastic pipe with heat-fused joints & fittings in accordance with ASTM D 2513. Provide anodeless risers to transition

between underground PE pipe and above ground black iron pipe. Provide yellow insulated copper tracer wire adjacent to all underground PE pipe. Terminate the tracer wire above grade at each end of the PE pipe.

3.4 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.

B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.

C. Piping Line Valves, NPS 2 (DN 50) and Smaller: Gas valve.

D. Piping Line Valves, NPS 2-1/2 (DN 65) and Larger: Plug valve or general-duty valve.

3.5 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 23 Section "Common Work Results for HVAC."

B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Floors: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in floors, subject to approval of authorities having jurisdiction. Surround piping 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: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
4. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
    a. Exception: Tubing passing through partitions or walls.
5. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.
6. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    a. Exception: Accessible above-ceiling space specified above.

C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

D. 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.

E. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

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

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

H. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

I. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

J. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

K. Install flanges on valves, specialties, and equipment having NPS 2-1/2 (DN 65) and larger connections.

L. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

M. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.6 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 23 Section "Common Work Results for HVAC."

B. Use materials suitable for fuel gas.

C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

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

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

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

1. Do not use gas pipe as grounding electrode.

F. Connect wiring according to Division 26 Section "Building Wire and Cable."

3.9 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.

1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
2. Nameplates, pipe identification, and signs are specified in Division 23 Section "Mechanical Identification."

3.10 PAINTING

A. Use materials and procedures in Division 09 Sections.

B. Paint exterior service meters, pressure regulators, and specialty valves.

1. Color: Gray.

C. Paint gas piping.

1. Color: Yellow (1 primer, 2 finish coats).

3.11 FIELD QUALITY CONTROL

A. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

C. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

D. Verify correct pressure settings for pressure regulators.

E. Verify that specified piping tests are complete.

END OF SECTION 22 11 23

SECTION 22 12 00

WATER SUPPLY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including applicable portions of Division 1 – General Requirements of the Specifications apply to this Section.

1.02 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.

B. All work of this section shall be completed in conformance with Westchester County Departments of Environmental Facilities and Westchester County Health Department standards.

C. Prior to installation, all water main connections and/or relocations shall be approved by the owner of the water works.

1.03 SUBMITTALS

A. Product Data: For pipe and fittings indicated.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water.
   2. Comply with Westchester County Health Department standards and all local authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

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

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

E. NSF Compliance:
   1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.05 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager and the Owner not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Construction Manager and Owner permission.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves and fire hydrants, according to the following:
1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

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

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

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

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

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

PART 2 - PRODUCTS

2.01 DUCTILE-IRON PIPE AND FITTINGS

A. Push-on-Joint, Ductile-Iron Pipe: Class 54 pipe manufactured in accordance with AWWA C151, latest version. Double Cement Lined, AWWA C104, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile
2. Gaskets: AWWA C111, rubber.

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

C. Fittings shall be furnished with a seal coated cement mortar lining with the same thickness specified for the corresponding size of ductile iron pipe.

2.02 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
1. Nonrising-Stem, Resilient-Seated Gate Valves:
a. Description: Ductile-iron body and bonnet; with ductile-iron gate, resilient seats, bronze stem, and stem nut.
1) Standard: AWWA C509.

2) Minimum Pressure Rating: 250 psig.
3) End Connections: Mechanical joint.
4) Interior Coating: Complying with AWWA C550.

2.03 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:
1. Description: Sleeve and valve compatible with drilling machine. Use only when approved by owner of water main.
a. Tapping Sleeve: Ductile-iron, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
b. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Install with all valves and shall comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5-inches in diameter.
1. Operating Wrenches: Supply one steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Refer to Section 312000 Earthwork for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

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

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

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

D. Underground water-service piping NPS 4 to NPS 8 shall be the following:
1. Ductile-iron, push-on-joint pipe; and mechanical-joint fittings.

3.03 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of Westchester County Department of Environmental Facilities and/or the Westchester County health Department. The tap is to be of the size indicated and in the location shown on the plans.

B. Make connections larger than NPS 2 with tapping machine according to the following:
1. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
2. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
3. Install gate valve onto tapping sleeve. Install valve with stem pointing up and with valve box.

C. Bury piping with depth of cover over top of pipe at least 48-inches.

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

3.04 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
   1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

3.05 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Bolted flanged joints.
   3. Megalug mechanical joint restraint system, or approved equal.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

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

3.06 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

3.07 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide gravel for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

3.08 FIELD QUALITY CONTROL

A. Piping Tests: Fill pipeline minimum twenty-four (24) hours before testing and apply test pressure to stabilize system. Use only potable water. Conduct all testing in strict accordance with Westchester County Health Department and Westchester Medical Center.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure or 150 psi minimum for two hours.

   1. Pressure / Leakage Testing shall be performed in accordance with the latest edition of AWWA Standard 600.
   2. Disinfection and Bacteriological test will be performed in accordance with AWWA standard C651-92 except for Section 5.1.

C. Prepare reports of testing activities.

3.09 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 Earthwork.

3.10 CLEANING

A. Clean and disinfect water-distribution piping as follows:
   1. Disinfection shall be conducted in accordance with Westchester County Health Department regulations and requirements.
   2. All pipe and fitting shall be swabbed and cleaned with chlorine prior to installation.
   3. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   4. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
      a. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 12 00

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SECTION 22 13 13

FACILITY SANITARY SEWER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure and pressure couplings.
3. Deflection fittings.
4. Cleanouts.
5. Manholes.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Deflection fittings.
2. Pipe

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Product Certificates: For each type of ductile iron pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle manholes according to manufacturer's written rigging instructions.

1.05 PROJECT CONDITIONS

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

1. Notify Construction Manager and Owners representatives no fewer than two days in advance of proposed interruption of service.

PART 2 - PRODUCTS

2.01 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile iron, for push-on joints.

C. Compact Fittings: AWWA C153, ductile iron, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.02 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Push-on-Joint Piping:

1. Pipe: AWWA C151.
2. Standard Fittings: AWWA C110, ductile.
3. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:

4. Pipe: AWWA C151, with bolt holes in bell.
5. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
6. Glands: Ductile iron; with bolt holes and high-strength steel bolts and nuts.
7. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

2.03 PVC PIPE AND FITTINGS

A. PVC Profile Sewer Piping:

1. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.04 MANHOLES

A. Designed Precast Concrete Manholes:

1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C 923, cast into manhole walls, for each pipe connection.
5. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12 inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
6. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
7. Exterior Coating: 2 coats, asphalt coating.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7 inch riser, with 4-inch minimum-width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "WCDEF."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.02 PIPING INSTALLATION

A. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

B. Install manholes for changes in direction. Use fittings for branch connections unless direct tap into existing sewer is indicated.

C. Install force-main, pressure piping according to the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 48-inch minimum cover.
3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings according to AWWA C600.

D. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
   1. Ductile-iron pipe and fittings.
   2. Expansion joints and deflection fittings.

E. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.03 PIPE JOINT CONSTRUCTION

A. Join force-main, pressure piping according to the following:

   1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

   2. Use pressure pipe couplings for force-main joints.

3.04 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

3.05 CONNECTIONS

A. Make connections to existing piping and underground manholes.

   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 4000 psi.

   2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.06 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Excavate and remove pipe and legally dispose of them off the Owner's property.

B. Abandoned Manholes: Excavate and remove manhole and legally dispose of them off the Owner's property.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.07 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.08 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.

5. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6.

6. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.

    a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.

7. Manholes: Perform hydraulic or vacuum test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.09 CLEANING

A. Clean dirt and superfluous material from interior of piping.

END OF SECTION 22 13 13

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground metal piping.

1.3 PERFORMANCE REQUIREMENTS

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

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

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures" and International Building Code – New Jersey Edition – Latest Edition

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Sovent Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

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

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

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. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
   a. Manufacturers:
      1) ANACO.
      2) Fernco, Inc.

3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Charlotte Pipe & Foundry Co.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
   a. Manufacturers:
      1) ANACO.
      2) Clamp-All Corp.
      3) Ideal Div.; Stant Corp.
      4) Mission Rubber Co.
      5) Tyler Pipe; Soil Pipe Div.
      6) Charlotte Pipe & Foundry Co.
3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
   a. Manufacturers:
      1) MG Piping Products Co.

2.5 COPPER TUBE AND FITTINGS

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

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

B. Hard Copper Tube: ASTM B 88, Types L (ASTM B 88M, Types B and C), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 SPECIAL PIPE FITTINGS

A. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Mission Rubber Co.

B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Dresser, Inc.; DMD Div.
   c. EBAA Iron Sales, Inc.
   d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   e. JCM Industries, Inc.
   f. Romac Industries, Inc.
   g. Smith-Blair, Inc.
   h. Viking Johnson.
2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

C. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

1. Manufacturers:
   a. EBAA Iron Sales, Inc.

D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:
   a. EBAA Iron Sales, Inc.

b. Romac Industries, Inc.
c. Star Pipe Products; Star Fittings Div.

E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:
a. SIGMA Corp.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch minimum thickness.

B. Form: Sheet or tube.

C. Color: Black.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

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

B. Aboveground, soil and waste piping (EXCEPT IN THE KITCHEN) shall be any of the following:

1. Hubless cast-iron soil pipe and fittings and couplings; and hubless-coupling joints.
2. Copper DWV tube, copper drainage fittings, and soldered joints.
3. Solid-Wall Schedule 40 PVC Pipe with primed & cemented PVC socket fittings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) (EXCEPT IN THE KITCHEN) and larger shall be any of the following:

1. Hubless cast-iron soil pipe and fittings shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid-Wall Schedule 40 PVC Pipe with primed & cemented PVC socket fittings.

D. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:

1. Hubless cast-iron soil pipe and fittings shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid-Wall Schedule 40 PVC Pipe with primed & cemented PVC socket fittings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger shall be any of the following:

1. Hubless cast-iron soil pipe and fittings shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid-Wall Schedule 40 PVC Pipe with primed & cemented PVC socket fittings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) (EXCEPT IN THE KITCHEN) and smaller shall be any of the following:

1. Service class, cast-iron bell and spigot type soil pipe with gasketed joints.
2. Solid-Wall PVC Pipe with primed & cemented PVC socket fittings.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:

1. Service class, cast-iron bell and spigot type soil pipe with gasketed joints.
2. Solid-Wall PVC Pipe with primed & cemented PVC socket fittings.

H. Aboveground, waste piping in the Kitchen shall be:

1. Hubless cast-iron soil pipe and fittings shielded, stainless-steel couplings; and hubless-coupling joints.

I. Aboveground, vent piping in the Kitchen shall be:

1. Hubless cast-iron soil pipe and fittings shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid-Wall PVC Pipe with primed & cemented PVC socket fittings.

J. Underground, waste, and vent piping in the Kitchen shall be ONLY:

1. Service class, cast-iron bell and spigot type soil pipe with gasketed joints.

3.3 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Basic Mechanical Materials and Methods."

D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

E. 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.

F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 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.

G. 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.

H. Install 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 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) 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.

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

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

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.

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

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

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

D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "Valves."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration Controls and Seismic Restraints."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports."

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

E. Rod diameter may be reduced 1 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 (DN 40 and DN 50): 60 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
4. NPS 6 (DN 150): 60 inches with 3/4-inch rod.

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

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

1. NPS 1-1/4 (DN 32): 84 inches with 3/8-inch rod.
2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 11 feet with 1/2-inch rod.
5. NPS 3 (DN 80): 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.
7. NPS 6 (DN 150): 12 feet with 3/4-inch rod.

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

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): 84 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 96 inches with 1/2-inch rod.
3. NPS 4 (DN 100): 108 inches with 1/2-inch rod.
4. NPS 6 (DN 150): 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

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

1. NPS 1-1/4 (DN 32): 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
3. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet with 1/2-inch rod.
5. NPS 6 (DN 150): 10 feet with 5/8-inch rod.

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

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

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

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. 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 (DN 65) and larger.

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

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

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

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

END OF SECTION 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. This Section includes the following drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Miscellaneous drainage piping specialties.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

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

B. Manufacturer Seismic Qualification Certification: Submit certification that all accessories, and components will withstand seismic forces defined in Division 22 Section "Plumbing Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

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

1.5 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 and storm piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

1.7 EXTRA MATERIALS

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

1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Metal Floor Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Or approved equal.

B. Stainless Steel Wall Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Or approved equal.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Or approved equal.
4. Standard: ASME A112.6.3 with backwater valve.

5. Pattern: Floor drain.
6. Outlet: Side.
7. Sediment Bucket: Refer to plumbing schedule.
8. Top or Strainer Material: Bronze.
9. Top of Body and Strainer Finish: Nickel bronze.
10. Top Shape: Round.

2.3 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Open Drains:

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

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2 (DN 50): 4-inch minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:

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

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [1 inch (25 mm)] [2 inches (51 mm)] <Insert dimension> above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

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

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

J. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.
3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
4. Size: Same as or larger than connected downspout.

K. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.4 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

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

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

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

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.

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 13 23

SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Grease interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PP: Polypropylene plastic.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

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

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

1.6 PROJECT CONDITIONS

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

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

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Grease Interceptors: Precast concrete complying with ASTM C 913.

1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
2. Structural Design Loads:
   a. Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
3. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into interceptor walls, for each pipe connection.
4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
5. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.
   a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
   b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
   c. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."

B. Capacities and Characteristics:

1. Refer to drawings for interceptor dimensions and pipe connections and sizes.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION

A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

C. Set tops of grating frames and grates flush with finished surface.

3.3 CONNECTIONS

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

B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 22 13 23

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SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground metal piping.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

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

1. Storm Drainage Piping: 80 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. 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."

E. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

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

B. Aboveground and underground storm drainage piping shall be:

1. Solid-wall Schedule 40 PVC pipe with primed and cemented socket fittings.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 2 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 15 Section "Plumbing Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."

F. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

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

H. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

J. Install engineered controlled-flow storm drainage piping in locations indicated.

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

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 15 Section "Valves."

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 15 Section "Hangers and Supports."

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

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

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

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
4. NPS 6 (DN 150): 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches with 7/8-inch rod.

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

3.6 CONNECTIONS

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

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

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

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, 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. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.8 CLEANING

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

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

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

END OF SECTION 22 14 13

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Miscellaneous drainage piping specialties.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

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

B. Manufacturer Seismic Qualification Certification: Submit certification that all accessories, and components will withstand seismic forces defined in Division 22 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

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

1.5 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 and storm piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

1.7 EXTRA MATERIALS

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

1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Metal Floor Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Or approved equal.

B. Stainless Steel Wall Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Or approved equal.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   a. MIFAB, Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Or approved equal.
4. Standard: ASME A112.6.3 with backwater valve.

5. Pattern: Floor drain.
6. Outlet: Side.
7. Sediment Bucket: Refer to plumbing schedule.
8. Top or Strainer Material: Bronze.
9. Top of Body and Strainer Finish: Nickel bronze.
10. Top Shape: Round.

2.3 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Open Drains:

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

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2 (DN 50): 4-inch minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:

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

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [1 inch (25 mm)] [2 inches (51 mm)] <Insert dimension> above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

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

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

J. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.
3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
4. Size: Same as or larger than connected downspout.

K. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.4 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

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

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

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

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.

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 14 23

SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible sump pumps.
2. Sump-pump basins and basin covers.

B. Related Section:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. [Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

1. Description: Factory-assembled and -tested sump-pump unit.
2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
4. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron design for clear wastewater handling, and keyed and secured to shaft.
5. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
6. Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   a. Motor Housing Fluid: Air.
8. Controls:
   a. Enclosure: NEMA 250, Type 4X.
   b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
   e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
9. Controls:
   a. Enclosure: NEMA 250, Type 4X wall-mounted.
   b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
   c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
10. Control-Interface Features:
    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
       1) On-off status of pump.
       2) Alarm status.

2.2 SUMP PUMP CAPACITIES AND CHARACTERISTICS

1. Refer to schedule on the drawings.

2.3 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Refer to schedule on the drawings.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 CONNECTIONS

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

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

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

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

END OF SECTION 22 14 29

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SECTION 22 34 00

FUEL-FIRED DOMESTIC-WATER HEATER

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, gas-fired domestic-water heaters.
2. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of commercial, gas-fired**,** domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. 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.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

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

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, 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, Gas-Fired, Domestic-Water Heater:
      1) Heater: Five years.
      2) Controls and Other Components: One year(s).
   b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS-FIRED DOMESTIC-WATER HEATER

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following.
   a. LAARS
   b. A.O. Smith
   c. Lochinvar
2. Domestic Hot Water Heater:
   a. The water heater shall have performance ratings as scheduled on the plans as manufactured by A.O. Smith Corporation, Water Products Company or approved equal.
   b. The heater shall be design certified by an ANSI approved/accredited independent rating laboratory. The boiler shall bear the ASME “H” stamp and shall be National Board registered for 160 PSI working pressure.
   c. Heater shall be up flow type having all non-ferrous waterways and employing a copper finned heat exchanger and a tightly wound copper coil combustion chamber.
   d. Heater shall be equipped with an electric gas valve of the step-opening type, an adjustable limit control which will break the electric circuit on temperature rise, intermittent ignition with one (1) second shutdown in the event of pilot flame failure, a gas pressure regulator properly set for the gas to be supplied, and a coil limit switch for shut off in event of excessive water temperature, a certified draft diverter and a fully illustrated instruction manual.
   e. Outer jacket shall be of baked enamel finish.
   f. The coil, heat exchanger and burner shall have a ten year limited warranty as outlined in the written warranty.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tank:

1. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tanks.

2. Manufacturers:
   a. AMTROL Inc.
   b. Bell & Gossett.
   c. Armstrong Pumps, Inc.
3. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish:
   c. Air-Charging Valve: Factory installed.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Comply with requirements for shutoff ball valves specified in Section 220523"Valves."

E. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

F. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type.

G. Combination Temperature-and-Pressure Relief Valves: 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.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heater specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heater to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.

B. Install 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 ball valves specified in Section 220523 "Valves."

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature and pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. 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 domestic-water heaters that do not have tank drains.

G. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill domestic-water heaters with water.

J. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

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

D. Where installing piping adjacent to fuel-fired, 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.

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. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

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

END OF SECTION 22 34 00

SECTION 22 41 00

RESIDENTIAL 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. Bathtubs.
2. Faucets.
3. Lavatories.
4. Showers.
5. Kitchen sinks.
6. Dishwasher air-gap fittings.
7. Water closets.
8. Toilet seats.
9. Supply fittings.
10. Waste fittings.

B. Related Requirements:

1. Section 224213 "Commercial Water Closets."
2. Section 224214 "Commercial Urinals."
3. Section 224500 "Emergency Plumbing Fixtures."
4. Section 224713 "Drinking Fountains."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures of unit shell.
   b. Faulty operation of controls, blowers, pumps, heaters, and timers.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Residential Applications of Shells: Five years from date of Substantial Completion.
3. Warranty Period for Residential Applications of Electronic Controls: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 REFER TO THE PLUMBING FIXTURE SCHEDULE FOR MAKE AND MODELS OF ALL FIXTURES.

2.2 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 (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.

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

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

3.2 INSTALLATION

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

B. Install floor-mounted water closets on closet flange attachments to drainage piping.

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

D. Install pedestal lavatories on pedestals and secured to wood blocking in wall.

E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball or gate valves if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

F. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

G. Install toilet seats on water closets.

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

I. Install shower flow-control fittings with specified maximum flow rates in shower arms.

J. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes unless otherwise indicated.

K. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

L. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.

M. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

N. Set bathtubs and shower receptors in leveling bed of cement grout.

O. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

P. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

Q. Seal joints between plumbing fixtures, counters, 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 water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.4 ADJUSTING

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

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and fittings.

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

END OF SECTION 22 41 00

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SECTION 22 42 13

COMMERCIAL WATER CLOSETS

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. Flushometer valves.
3. Toilet seats.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for residential water closets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 REFER TO THE PLUMBING FIXTURE SCHEDULE FOR MAKE AND MODEL OF ALL FIXTURES.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

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

F. Joint Sealing:

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

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

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

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

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

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13

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SECTION 22 42 14

COMMERCIAL URINALS

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. Urinals.
2. Flushometer valves.

B. Related Requirements:

1. Section 224600 "Security Plumbing Fixtures" for security urinals.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 REFER TO THE PLUMBING FIXTURE SCHEDULE FOR MAKE AND MODEL OF ALL FIXTURES.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

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

3.2 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
5. Install trap-seal liquid in waterless urinals.

B. Support Installation:

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

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

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

E. Joint Sealing:

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

3.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

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

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

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

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 14

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SECTION 22 45 00

EMERGENCY 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. Eyewash equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

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

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Flushing-Fluid Solution: Separate lot and equal to at least [**200**] <**Insert number**> percent of amount of solution installed for each self-contained unit.

1.8 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. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

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

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

PART 2 - PRODUCTS

2.1 EYEWASH EQUIPMENT

A. Sink, Swivel-Type, Plumbed Eyewash Unit:

1. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
2. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
4. Spray-Head Assembly: Two spray heads with offset piping.
5. Mounting: Deck next to sink.

2.2 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties."

F. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

G. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

J. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

K. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Connect steam and cold-water-supply and condensate return piping to steam and cold water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping" and comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties."

D. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

E. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

F. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

G. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 22 45 00

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SECTION 22 47 13

DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes drinking fountains and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Drinking Fountains: Wall Mounted Stainless Steel.

1. Stainless Steel Drinking Fountains:
   a. Provide Elkay EZH20 Bottle Filling Station Bi-Level Water Cooler or approved equal. Refer to schedule for specific model number and accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

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

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains on floor.

C. Install recessed drinking fountains secured to wood blocking in wall construction.

D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

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

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

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

3.5 CLEANING

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

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

C. Provide protective covering for installed fixtures.

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

END OF SECTION 22 47 13

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SECTION 22 53 00

PERFORMANCE IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general conditions of the contract apply to work specified in this section. Consult them in detail for applicable instruction.

1.2 SUMMARY

A. Supply all labor material tools and equipment necessary to furnish and install the automatic Exterior Irrigation System which includes all related plumbing and electrical work. Such Work shall include but is not necessarily limited to the following:

1. Testing at site to verify static and working pressure available for irrigation
2. System design layout
3. Provide layout drawings and description of operation
4. Construction details
5. Excavation and backfill of trenches and pits in the planters.
6. Wiring, Piping and Valves from the main feed line to the control unit and from the control unit to the existing water and electrical source
7. Controllers
8. Drip hoses, Sprinklers and Emitters
9. Electrical and plumbing connection to source
10. Lines to each lawn and planting location
11. Rain shutoff
12. Proper backflow protection devices and filters according to local codes, ordinances
13. As built drawings

14. Testing, adjustment and guarantee

15. Shop drawings

16. Quick Coupling Valves

B. This Section requires the Contractor to supply material certification and related as data required or specified herein material, installations, including related plumbing under the structural slab.

C. The materials method of manufacture and installation procedures as itemized in this section are intended as a guide specification to obtain acceptable standards.

D. The irrigation work is to be provided by performance requirement only. The area to be automatically irrigated shall be as shown on the Shop Drawings and Plans. Performance requirement will be standard coverage for all lawn and planting areas within the project limits but excluding street trees, with double coverage for all areas. The drip lines and sprinklers shall be laid out to accomplish the foregoing without causing adjacent walking and wall surfaces to become wet. Provide Quick Coupling Valves spaces to all project areas can be reached with a 150’ hose.

E. The irrigation system is to be placed in all planting beds and lawns as shown on the contract drawings. The Contractor is responsible for all aspects of the irrigation system from the water source to the drippers and sprinklers, excluding the main feed line. All plumbing and electrical connections tothe main feed line from the control unit to the existing water and electrical source shall be installed by the irrigation contractor and coordinated with the project plumber and electrician. Contractors shall become aware of the limitations placed upon the installation of the irrigation system.

F. The contractor shall locate all necessary controls.

1.3 RELATED SECTIONS

A. Planting

1.4 DELEGATED DESIGN

A. Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

A. Submit all of the following for approval.

1. Provide a system design layout drawings 1/8”=1-0’ scale or larger of the site plan, indicating piping, drippers, sprinklers, valves and controls, design, pressure, and all sizing of mains and laterals.

2. Provide catalogue cuts and manufacturer's literature for all components.

3. Provide Owner with manual of operations for system.

4. After completion of the piping installation, the Contractor shall furnish an "as Built" drawing showing all drippers, sprinklers, valves, pipelines to scale with dimensions where required, final pipeline layout. A minimum of two dimensions from building corners shall be used to indicate all valve and quick coupler locations. Instruction sheets and part lists covering all operating equipment will be bound into a folder and furnished to the Landscape Architect in duplicate. The As-Built Drawing shall be Owner's Representative prior to inspecting the system for final acceptance.

1.6 COORDINATION EXAMINATION AND VERIFICATION:

A. Contractor must coordinate all work with the project plumbing and electrical contractor.

B. Study the specifications and provide all layout drawings and descriptions necessary to ensure completeness of the work required under this section.

C. All work under this section shall be coordinated with the affected trades.

D. During the bidding period, verify all conditions at the site on which the work of the contract is dependent.

1.7 PROJECT CONDITIONS:

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

1. Notify Construction Manager and Owner no fewer than 5 days in advance of proposed interruption of water service.

2. Do not proceed with interruption of water service without Construction Manager and Owner's written permission.

PART 2 - PRODUCT

2.1 MATERIALS

A. Pipes

1. Polyvinyl chloride pipe (hereinafter referred to as PVC pipe) shall have been manufactured in accordance with the Commercial Standard 65 256 and the governing authority as applicable to mainline piping.

2. Main lines shall be polyvinyl chloride pipe PVC-1120 or PVC-1220 SDR 31 (Class 200) as per ASTM Standard in accordance with the material specifications. All under slab plumbing will comply with all applicable codes and regulations, including the use of copper piping.

3. Lateral piping shall be polyethylene plastic pipe, Schedule 40, conforming to the requirements of ASTM D-2104.

4. All pipes shall be continuously and permanently marked with the following information: manufacturer's name, pipe size, type of pipes and materials, SDR number or schedule, commercial standard number, and the NSF (National Sanitation Foundation) seal.

B. Pipe Sleeves Under Pavements & walks

1. Sleeves shall be installed for all irrigation pipe under non-soil areas. Sleeves shall be minimum two pipe sizes larger than the total size of pipe going through them, minimum sleeve size shall be 3 inch. PVC plastic, minimum Class 160, SDR 26, water pipe shall be used.

C Fittings

1. All pipe fittings shall be of the same material as the pipe specified and shall be compatible with the pipe furnished.

D. Valves, Drippers, and Related Components:

1. Backflow preventer devices, double check assemblies, pressure regulators, filters, drip lines & emitters with root guards, master valves, electric valves, valve caps, valve key and key heads, riser, hose bibs, boxes for control valves etc., should any or all be incorporated into Works include the following:

a. Netafim USA

b. Rain Bird Corporation

c. Toro Company (The); Irrigation Division

Supply manufacturer's data for all components of the irrigation system.

E. Sprinklers:

1. Rotary Sprinklers

a. Vandal proof, commercial grade

b. Hunter 'I' Series sprinklers or approved equal

2. Spray Sprinklers or Nozzles

    a. Commercial/ institutional grade

    b. Hunter “institutional spray” Series or approved equal

F. Remote Valves: Electric

1. Remote valves shall be supplied in accordance with the Specifications and shall be of size and number to enable soundoperation.

2. Valves shall be installed in a level position. Valves shall be installed deep enough so that there will be at least 12 inches of cover over the valves. Provide valve boxes at all locations

3. Valve boxes shall be installed flush withsoil.

G. Wiring:

1. Wire from the automatic control to the valves shall be supplied in order to enable sound operation of the system. All wiring shall be in accordance with the manufacturer's requirements, the NEC, and all the applicable codes and regulations.

H. Controllers:

1. All controllers shall be electric automatic; shall be sufficient to operate the system, and as recommended by the manufacturer. Controls shall have the capacity to operate the number of stations required by the system. The system needs to save a minimum of 35% as stated by the manufacturer.

2. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.

    A. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.

    B. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.

    C. Surge Protection: Metal-oxide-varistor type on each station and primary power.

3. The controllers shall be located in the building where and as directed by the Project Engineer.

4. All wiring for controllers shall comply with all applicable codes and

regulations.

I. Testing:

1. The Irrigation System shall be tested under normal water pressure and proven tight. If leaks occur, the joint or joints shall be replaced and test repeated.

J Electrical and Plumbing Connections: Electrical and plumbing connections shall be made by the Contractor, coordinating with the project plumbing and electrical contractor, in strict conformance with all codes. During rain for each Irrigation System, moisture sensor shall have minimum 35% water saving coefficient. Provide separate meter pits for each Irrigation System.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Where possible, all irrigation piping and conduits shall run along existing utility pipe chase. Contractor shall use extreme caution and keep wall and slab penetrations for irrigation equipment and materials to a minimum. Prior to beginning the work, submit a detailed layout drawing for review and approval by the Project Engineer. The drawing shall indicate water design pressure, pipe layout and size both above and below the structural slab, slab penetration and methods of sealing waterproofing, dripper types and location, coverage patterns, valve sizes and location, ground hydrant, and controls. Drawings shall also indicate phase and sequence of operation.

2. Before installation is started, place a stake where each dripper and ground hydrant is to be located and in accordance with the Contractor's layout drawing. The staking shall be approved by the Project Engineer before installation is started.

3. Excavation: Excavation for the drip irrigation system shall be sufficient enough for the proper installation of the pipe, valves and drip lines.

4. All rubble and deleterious matter shall be removed from the trenches.

Pipe shall have a firm, uniform bearing for the entire length of pipeline to prevent uneven settlement. Wedging or blocking of pipe will not be permitted. The Contractor shall not lay PVC pipe when there is water in the trench, or lay pipe when temperature is 32 degrees F, or below.

5. All foreign Matter or dirt shall be removed from inside the pipe before welding the pipe and the piping shall be kept clean by approved means during and after laying the pipe.

6. Ample precautions shall be taken to prevent damage to all plant materials, planters and structural slab. All piping shall be routed around trees and shrubs in such a manner as to avoid damage to planting. In the case of newly planted trees, no digging shall be done within the ball of the tree.

7. Exercise care in handling, locating, unloading, and storing pipe. Any section of pipe that has been dented or damaged will be discarded unless said section of pipe is cut out and replaced with a coupling.

8. Use only the solvent supplied and recommended by the manufacturer to make the solvent welded joints, in the manner prescribed by the manufacturer.

9. Mainline and lateral pipes shall be non-visible, covered, and protected.

10. Dripline shall be installed by hand. For at grade installation, any portion of dripline shall not be visible through the mulch. For below grade installation, dripline shall have root guard and installed at an average depth of 6 inches, minimum depth 4", and maximum depth of 8 inches. Dripline shall be installed 4 inches from all edges, curbs, and walls. Dripline spacing shall be as recommended by the supplier for each specific lawn/plant/tree type.

11. Drip Emitters: Emitters shall be installed in proper relationship to final grades.

12. Backfilling: Because of the expansion and contraction of pipe, backfilling cool part of the day. Selected fill dirt or sand shall be used. All backfill shall be carefully placed and compacted in order to prevent settling.

13. All tests shall be completed prior to backfilling. However, sufficient backfill material may be placed in trenches between fittings to insure the stability of the line under pressure. In all cases, fittings and couplings must be open to visual inspection for the full period of the test.

B. Final Adjustments

1. After installation has been completed, final adjustment shall be made of the sprinkler system preparatory to the final inspection by the Owner's Representative.

2. Adjust sprinkler heads, valve boxes, and quick coupling valves to grade as required, so that they will not be damaged by mowing operations. Continue sprinkler coverage adjustment as required by settlement, etc., throughout the guarantee period.

3. The system shall be completely flushed to remove any and all debris from the lines by removing the nozzle from all heads on ends of lines and turning on the system.

4. All drippers and sprinklers shall be checked for proper operation, alignments, and the direction and coverage of mist and drip nozzles.

5. Prevailing wind conditions may indicate misting and/or drip coverage should be other than as shown on the plan. In this case nozzles shall be changed to provide correct coverage at the Contractor's expense.

6. Prior to final acceptance, the entire irrigation system shall be adequately tested and adjusted to ensure complete operation sequences, and that all planter and structural slab penetrations related to the irrigation system are watertight.

C. Protection

Contractor shall be responsible for work until finally inspected tested and accepted. After delivery and before installation, the Contractor must protect work against theft, injury or damage. He shall carefully store material received on site which is not immediately installed. He shall close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material.

D. Cooperation and Clean Up

1. Cooperate fully with the other Contractors on the job site and leave the site in a clean and safe condition.

2. Upon completion of the job, the Contractors shall immediately remove all of his tools, equipment and any surplus materials and all debris caused by his portion of the work.

E. Warranty and Guarantee

1. The Contractor shall be held strictly responsible for all parts of the work including related plumbing. All materials are fully guaranteed for one year to be without defect, of standard quality or better and the installed system is guaranteed for one year from date of acceptance to give uniform distribution and even coverage of moisture, provided the water pressure does not drop below the design pressure of the system.

2. Provide all necessary equipment and perform all work required for testing pipe leakage. All leakage tests shall be made under the supervision of the Project Engineers, who shall be notified two (2) days prior to time of testing.

3. If failure in the irrigation system or appurtenances (including watertight seals of planter and structural slab penetrations) develop within one year from the date of final acceptance of the work, the Contractor shall be required to replace or repair all faulty materials at his/her expense. The Contractor is advised to purchase material under a warranty from the manufacturer, guaranteeing proper service conditions which are established by the contract drawings, specifications and

local conditions.

4. Labor and material to fulfill the requirements of this guarantee, shall be furnished by the Contractor at no additional cost to the Owner.

5. Maintenance of the system, i.e. raising and lowering of heads to compensate for growth, cleaning and adjustment of head, shall be given the purchaser of this system at no charge for one year, from the Notice of Physical Completion.

6. Provide Owner with manual outlining operation and periodic maintenance for the system

END OF SECTION 22 53 00

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SPECIFICATIONS GROUP

Facility Services Subgroup

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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SECTION 23 00 00

MECHANICAL SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 23, and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Work covered under Mechanical contract.
2. Work under other contracts.
3. Use of premises.
4. Owner's occupancy requirements.
5. Specification formats and conventions.

B. Related Sections include the following:

1. Division 23 Sections.

1.3 WORK COVERED UNDER MECHANICAL CONTRACT

A. Provide all labor, materials, tools, machinery, equipment, and services necessary to complete the mechanical work under this contract. All systems and equipment shall be complete in every respect and all items of material, equipment, and labor shall be provided for a fully operational system. Coordinate the work with work of other trades so as to resolve conflicts without impeding job progress. The mechanical work includes the following:

B. MECHANICAL

1. The mechanical contractor shall furnish all labor, materials, equipment, rigging, appliances, tools and accessories required for providing, installing, connecting and testing the new mechanical/HVAC system, associated work, controls etc., in accordance with these specifications and the applicable drawings. The work includes:

a. Furnish, install, new indoor/outdoor, packaged HVAC equipment, split system equipment, makeup air units, exhaust, fans, etc. as indicated on the drawings complete with its associated supports, VFD’s (where indicated on drawings) vibration isolation, ductwork, gas piping, refrigerant piping, condensate drain piping, insulation of all piping/ductwork, air outlets/inlets, dampers, valves, gauges, controls, etc for a complete operating system. (All electrical work associated with mechanical/HVAC systems shall be performed by the electrical contractor).

b. All cutting, core drilling, trenching, framing, lintels, etc. shall be coordinated with the General Contractor.

c. Furnish and install exhaust fans complete with 18" high aluminum roof curb, fan switch, interlock wiring, thermostat (where called out on the drawings for electrical rooms), backdraft dampers, etc. for a complete operating system.

d. Furnish and install gas fired unit heaters complete with supports, gas piping, valves, regulators, thermostat, disconnect switch, insulation, etc. for a complete operating system.

e. Furnish and install new VAV boxes complete with acoustical IAQ liner, DDC controls, control transformer zone sensor, thermostat, disconnect switch, control wiring etc. for a complete operating system.

f. Furnish and install new air outlets, inlets, transfer grilles of types and quantities as indicated on the drawings. All air outlets/inlets for corridors, kitchen and toilets shall be aluminum construction. Color to be selected by the owner.

g. Furnish and install new supply, return, exhaust and transfer air ductwork as indicated on the drawings. All ductwork shall be galvanized steel construction, except the 100% outside air duct system, outdoor air ducts, and exterior mounted ductwork, which shall be aluminum construction. All aluminum construction ductwork shall be SMACNA Class "A" sealed.

h. All supply, return and outdoor air ductwork shall be internally/externally insulated.

i. Provide high efficiency electric motors for all new units.

j. Furnish and install refrigerant piping and condensate drain piping with insulation, supports, etc.

k. Furnish and install motorized dampers.

l. Furnish and install volume dampers at all supply diffusers, return registers, exhaust registers.

m. Furnish and install fire dampers of suitable rating at all duct penetrations through all rated partitions (chase, wall, floor), whether indicated on the drawings or not.

n. Furnish and install flexible duct connectors at all duct connections to al HV/HVAC units.

o. Provide fire stopping for all duct and piping penetrations through rated walls/slabs with pipe escutcheons.

p. Furnish and install condensate drain piping with condensate drain pump, where required, complete check valves, insulation, etc. for a complete operating system.

q. Furnish and install new gas piping to new roof top equipment as well as to heater/other appliances. Coordinate installation with local gas company. Provide gas shut off valves and gas pressure regulators for each equipment. Provide gas pipe supports with stainless steel rollers for roof top gas piping. (Note – All gas

piping shall be in the Plumbing Contractor's scope of work. This is for information only).

r. Furnish and install anchors, guides, mechanical expansion joints for hot water piping.

s. Provide new Building Management System including front end web and PC based to monitor, program, and adjust remotely unit operations and space temperature settings. Refer to specification section 230923 and drawings for details.

t. Furnish and install all ancillary equipment needed for a complete and proper installation including, but not limited to anchors, hangers, expansion loops, fittings, strainers, valves, union, etc.

u. All ductwork shall be properly fabricated, installed and supported as per SMACNA and ASHRAE guidelines. Contractor to perform duct leakage testing of entire ductwork.

v. Contractor to perform testing, adjusting and balancing (TAB) of the entire mechanical and HVAC system, including all the indoor/roof top HV/HVAC/split AHU's, hot water distribution system, air side distribution, air outlets/inlets etc. Submit six (6) sets of air, water and unit TAB reports for review.

w. The entire piping system shall be hydrostatically tested for a minimum of two (2) hours at a minimum of 150 psig or 1.5 times the working pressure, whichever is higher. Submit six (6) sets of pressure testing report for review.

x. Submit six (6) sets of shop drawings of all equipment, sheet metal standards, piping standards, air outlets/inlets, supports, louvers, roof vents, controls, electricals, wiring diagram, etc.

y. Contractor to prepare as-built drawings of the entire mechanical/HVAC system. Submit six (6) sets of Operation and Maintenance Manuals.

z. Testing, Adjusting and Balancing (TAB) shall be done during the respective season for the units, during the summer season for cooling mode and during winter for heating mode.

aa. Contractor to provide sixteen (16) hour operator training for new DDC controls for owner designated personnel (broken up into as many sessions as requested by the owner) encompassing responding to alarms, events, messages and incidents, the use of reports, displaying point information, monitoring system status, managing building control applications, area and alarm segregation, and operator set-up and password assignment. THE TRAINING SHALL BE VIDEO TAPED. PROVIDE TWO (2) COPIES OF VIDEO TAPES FOR FUTURE REFERENCE BY THE OWNER.

bb. Contractor to provide sixteen (16) hour operator training for new equipment for owner designated personnel (broken up into as many sessions as requested by the owner) encompassing operation, maintenance, troubleshooting, filter replacement, etc. THE TRAINING SHALL BE VIDEO TAPED. PROVIDE TWO (2) COPIES OF VIDEO TAPES FOR FUTURE REFERENCE BY THE OWNER.

cc. Provide one (1) set of spare filters for each unit.

dd. Provide color coded identification tags, identification markers and equipment tags for all equipment including Roof Top/Indoor HV/HVAC/Split units, fans, pumps, boilers, ductwork, gas piping, hot water piping, cold water piping, condensate piping, valves, control valves, motorized dampers, relief vents, etc.

ee. Warranty: The entire system shall be warranted for a period of two complete years from the date of acceptance by the owner, including all materials and labor components.

ff. Between eleventh and twelfth month from the date of first startup for each piece of equipment of the complete HVAC system, the contractor shall re-commission the entire HVAC system including all units, outside air settings, airside systems, and waterside systems, to ensure performance, as per design drawings and specifications.

1.4 WORK UNDER OTHER CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.5 USE OF PREMISES

A. General: Each Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Owner Occupancy: Allow for Owner occupancy of Project site and use by the public.

2. Driveways and Entrances: Keep driveways parking garage, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
   a. Schedule deliveries to minimize use of driveways and entrances.

   b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of Existing Building: Maintain existing building in a weather tight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

1.6 OWNER'S OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.

2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

B. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.

2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.

3. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed.

1.7 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI/CSC's "MasterFormat" numbering system.

1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.

2. Division 1: Sections in Division 1 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 23 00 00

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. HVAC demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

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

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

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

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

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

F. The following are industry abbreviations for plastic materials:

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

G. The following are industry abbreviations for rubber materials:

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

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

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

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

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

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

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Acceptable Manufacturers:
   a. Eslon Thermoplastics.
   b. Charlotte Pipe and Foundry Company.
   c. Cresline Plastic Pipe Co.

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

1. Acceptable Manufacturers:
   a. Thompson Plastics, Inc.
   b. Genova Products.
   c. King Brothers Industries.

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

1. Acceptable Manufacturers:
   a. NIBCO INC.
   b. NIBCO, Inc.; Chemtrol Div.
   c. Genova Products.

2.5 DIELECTRIC FITTINGS

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

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

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

1. Acceptable Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Eclipse, Inc.
   d. Epco Sales, Inc.
   e. Hart Industries, International, Inc.
   f. Watts Industries, Inc.; Water Products Div.
   g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

1. Acceptable Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   d. Watts Industries, Inc.; Water Products Div.

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

1. Acceptable Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Acceptable Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.
   c. Epco Sales, Inc.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

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

2.6 MECHANICAL SLEEVE SEALS

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

1. Acceptable Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

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

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

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

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

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

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

1. Finish: Polished chrome-plated and rough brass.

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

1. Finish: Polished chrome-plated and rough brass.

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

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

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

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

2.9 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

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

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

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

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

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

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

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

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-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 and set screw.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

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

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

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

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

1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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

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

T. Verify final equipment locations for roughing-in.

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

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

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

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

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

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

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

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

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

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

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

3.4 PIPING CONNECTIONS

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

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

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

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

3.6 PAINTING

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

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

3.7 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 4000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

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

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

3.10 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 23 05 00

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SECTION 23 05 13

MECHANICAL EQUIPMENT MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes basic requirements for factory and field-installed motors.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.4 SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; enclosure type and mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

1. Each installed unit's type and details.
2. Nameplate legends.
3. Diagrams of power, signal, and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around field-installed motors. Show motor layout, mechanical power transfer link, driven load, and relationship between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that motors, accessories, and components will withstand seismic forces defined in Division 23 Section "Mechanical Vibration and Seismic Controls. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain field-installed motors through one source from a single manufacturer.

C. Product Options for Field-Installed Motors: Drawings indicate size, profiles, and dimensional requirements of motors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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

E. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with the following:
   a. Magnetic controllers.

b. Multispeed controllers.
c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory and field installed motors except as follows:

1. Different ratings, performance, or characteristics for motor are specified in another Section.
2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase (unless otherwise indicated on drawings). All motors shall be high-efficiency premium motors.

B. Motors Smaller Than 1/2 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open drip proof.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium as defined in NEMA MG 1.

C. Stator: Copper windings, unless otherwise indicated.

1. Multispeed motors shall have separate winding for each speed.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

C. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before motor installation.

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

3.2 FIELD-INSTALLED MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Install motors on concrete bases complying with Division 3.

C. Comply with mounting and anchoring requirements specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

3.3 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

A. Prepare for acceptance tests.

1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
2. Verify bearing lubrication.
3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
4. Test interlocks and control and safety features for proper operation.
5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

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

C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

E. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical tests and visual and mechanical inspections optional tests and inspections stated in NETA ATS on factory and field installed motors. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.4 FIELD-INSTALLED MOTOR DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain field-installed motors. Refer to Division 1 Section “Closeout Procedures."

END OF SECTION 23 05 13

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

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

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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 sleeves in first paragraph below may be prohibited by fire authorities having jurisdiction.

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

F. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) 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. PVC sleeves in paragraph below may be prohibited by fire authorities having jurisdiction.

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

2.02 STACK-SLEEVE FITTINGS

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

B. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

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

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

C. Pressure Plates: Stainless steel.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 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.

2.05 GROUT

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

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

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

D. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

E. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

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

G. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

H. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

I. Install sleeves for pipes passing through interior partitions.

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

K. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

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

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

3.02 STACK-SLEEVE-FITTING INSTALLATION

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

B. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

C. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

E. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

F. Using grout, seal the space around outside of stack-sleeve fittings.

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

3.03 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.

3.04 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.

3.05 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system
   b. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   c. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
   d. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
   b. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   c. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
   d. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
5. 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 23 05 17

SECTION 23 05 18

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

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

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

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

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.02 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

3.01 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.

C. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
2. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
3. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
5. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
6. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
7. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
8. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
9. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
10. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
11. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

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

E. 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.

3.02 FIELD QUALITY CONTROL

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

END OF SECTION 23 05 18

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 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. Equipment supports.

B. Related Sections:

1. Section 230548 "Mechanical Vibration and Seismic Controls" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 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.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.
5. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Fiberglass strut systems. Include Product Data for components.
4. Pipe stands. Include Product Data for components.
5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

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: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or [ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

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

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

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

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

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel 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: Stainless steel.
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. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 EQUIPMENT SUPPORTS

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

2.7 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

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 (DN 65)] <Insert size> 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 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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 ADJUSTING

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

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

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Interior Painting".

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

3.5 HANGER AND SUPPORT SCHEDULE

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

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

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

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

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

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

END OF SECTION 23 05 29

SECTION 23 05 48

MECHANICAL VIBRATION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Elastomeric isolation pads and mounts.
2. Restrained elastomeric isolation mounts.
3. Freestanding and restrained spring isolators.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Thrust limits.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Freestanding and restrained air spring isolators.
12. Restrained vibration isolation roof-curb rails.
13. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. A_v: Effective peak velocity related acceleration coefficient.

1.4 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and

rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping tests performed by an independent laboratory or acoustician.

E. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 VIBRATION ISOLATORS

A. Available Manufacturers:

B. Manufacturers:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Eliminator Co., Inc.
4. Vibration Isolation Co., Inc.

C. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene or Natural rubber.
2. Number of Layers: Multiple.

D. Restrained Elastomeric Mounts: All-directional elastomeric mountings with seismic restraint.

1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

G. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers:

B. Manufacturers:

1. Mason Industries, Inc.
2. Vibration Eliminator Co., Inc.
3. Vibration Isolation Co., Inc.

2.4 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electro-galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

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 INSTALLATION

A. Install seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

B. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

C. Install resilient bolt isolation washers on equipment anchor bolts.

3.3 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.4 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

C. Testing: Perform the following field quality-control testing:

1. Isolator seismic-restraint clearance.
2. Isolator deflection.
3. Snubber minimum clearances.
4. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
5. Air-Mounting System Operational Test: Test the compressed-air leveling system. Remove malfunctioning units, replace with new units, and retest.
6. Test and adjust air-mounting system controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-Mounting System Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping connections. Report results in writing.

1. Isolator seismic-restraint clearance.
2. Isolator deflection.
3. Snubber minimum clearances.
4. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
5. Operational Test: Test the compressed-air leveling system. Remove malfunctioning units, replace with new units, and retest.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment 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.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust air spring leveling mechanism.

E. Adjust active height of spring isolators.

F. Adjust snubbers according to manufacturer's written recommendations.

G. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

H. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.6 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Closeout Procedures".

END OF SECTION 23 05 48

SECTION 23 05 53

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Duct markers.
7. Stencils.
8. Valve tags.
9. Valve schedules.
10. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
   a. Manufacturer, product name, model number, and serial number.
   b. Capacity, operating and power characteristics, and essential data.
   c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.

1. Stencil Material: Metal or fiberboard, Aluminum, or Brass.
2. Stencil Paint: Exterior, gloss, acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch thick brass or aluminum.
2. Material: 0.0375-inch thick stainless steel.
3. Material: 3/32-inch thick laminated plastic with 2 black surfaces and white inner layer.
4. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 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 minimum.
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 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where

not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, and stills.
2. Pumps, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HV/HVAC (central-station and zone-type units), split HV/HVAC, indoor AHU's, etc.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 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.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Meters, gages, thermometers, and similar units.
    c. Fuel-burning units, including boilers, furnaces, and heaters.
    d. Pumps and similar motor-driven units.
    e. Heat exchangers, coils, and similar equipment.
    f. Fans, blowers, primary balancing dampers, and mixing boxes.
    g. Packaged HV/HVAC (central-station and zone-type units), split HV/HVAC, indoor AHU's, etc.
    h. Strainers, filters, water-treatment systems, and similar equipment.

C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

D. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:
    a. Green: For cooling equipment and components.
    b. Yellow: For heating equipment and components.
    c. Green and Yellow or Orange: For combination cooling and heating equipment and components.
2. Letter Size: Minimum 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.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:

a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
b. Fuel-burning units, including boilers, furnaces, and heaters.
c. Pumps and similar motor-driven units.
d. Heat exchangers, coils, evaporators, and similar equipment.
e. Fans, blowers, primary balancing dampers, and mixing boxes.
f. Packaged HV/HVAC (central-station and zone-type units), split HV/HVAC, indoor AHU's, etc.
g. Strainers, filters, water-treatment systems, and similar equipment.

E. Stenciled Equipment Sign Option: Stenciled signs may be provided instead of laminated-plastic equipment signs, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

F. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

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

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 non-accessible 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 markers.

3.4 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Blue: For exhaust, outside, relief, return, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
5. Letter Size: Minimum 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.

B. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; 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:

1. Valve-Tag Size and Shape:
   a. Cold Water: 2 inches round.
   b. Hot Water: 2 inches round.
   c. Gas: 2 inches round.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 WARNING-TAG INSTALLATION

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

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.
2. Additional Tests
   a. Sound testing.
   b. Vibration testing.
   c. Duct leakage testing.
   d. Controls verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. T&B: Testing, adjusting, and balancing

C. T&B Agency: An independent entity certified by AABC to perform testing and balancing work.

D. TBE: AABC certified test and balance engineer.

E. TBT: AABC certified test and balance technician.

F. HVAC: Heating, ventilating, and air conditioning.

G. BAS: Building automation systems.

H. Contract documents: the mechanical drawings and test and balance specification

I. NC: noise criteria

J. RC: room criteria

1.4 T&B INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation T&B of AABC certification of T&B agency and personnel, including a sample copy of the AABC "National Performance Guaranty." If not submitted within the timeframe specified, the engineer has the right to choose an AABC agency at the Contractor's expense.

B. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit T&B strategies and step-by-step procedures as specified in "Preparation" Article.

C. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article to be used and filled out by systems Installers verifying that systems are ready for T&B.

D. Examination Report: Within 30 days of Contractor's Notice to Proceed, provide a summary report of the examination review required in Part 3 "Examination", if issues are discovered that may preclude the proper testing and balancing of the systems.

E. Certified T&B reports: Within 14 days of completion of balancing work, submit AABC-certified T&B report.

1. Submit one copy of the final T&B Report directly to the design professional of record. Provide five additional copies to the contractor.

1.5 QUALITY ASSURANCE

A. T&B Agency Qualifications: Engage a T&B entity certified by AABC.

1. T&B Field Supervisor: Employee of the T&B Agency who is certified by AABC.
2. T&B Technician: Employee of the T&B Agency and who is certified by AABC as a TBT.

B. T&B Conference: If requested by the Engineer or Owner after approval of the T&B Agency's submittals, meet to develop a mutual understanding of the details. The T&B agency shall be provided a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Agenda Items:
   a. The examination report.
   b. The Strategies and Procedures plan.
   c. Systems readiness checklists.
   d. Coordination and cooperation of trades and subcontractors.
   e. Coordination of documentation and communication flow.

C. TBT shall perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified T&B reports.
2. Certify that the T&B team complied with the approved T&B plan and the procedures specified and referenced in this Specification.
3. Certify the T&B report.

D. T&B Report Forms: Use approved forms submitted with the Strategies and Procedures Plan.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in the "AABC National Standards for Total System Balance."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire T&B period. Cooperate with Owner during T&B operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during T&B operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 T&B AGENCY

A. Subject to compliance with requirements, engage one of AABC certified T&B Agencies:

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper T&B of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

E. Examine equipment performance data including fan curves.

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

G. Examine two-way valves for proper installation and function.

H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

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

J. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.

3.3 PREPARATION

A. Prepare a T&B plan that includes the following:

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 all equipment.

B. Prepare system-readiness checklists, as described in the "AABC National Standards for Total System Balance," for use by systems installers in verifying system readiness for T&B. These shall include, at a minimum, the following:

1. Airside:
   a. Ductwork is complete with terminals installed.
   b. Volume, smoke and fire dampers are open and functional.
   c. Clean filters are installed.
   d. Fans are operating, free of vibration, and rotating in correct direction.
   e. Variable-frequency controllers' start-up is complete and safeties are verified.
   f. Automatic temperature-control systems are operational.
   g. Ceilings are installed.
   h. Windows and doors are installed.
   i. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for T&B procedures.

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

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

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain approved submittals and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare single-line schematic diagram of systems for the purpose of identifying HVAC components.

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 functioning.

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

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
    a. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
2. Measure fan static pressures as follows:
    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.
3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust sub-main and branch duct volume dampers for specified airflow. Re-measure each sub-main and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.

2. Measure airflow at all inlets and outlets.
3. Adjust each inlet and outlet for specified airflow.
4. 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 and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust, if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located 2/3 of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control setpoint 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 that terminal is calling for maximum airflow (note some controllers require starting with minimum airflow. Verify calibration procedure for specific project).
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot deck and cold deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After all terminals 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 fan manufacturer.
    a. Set outside 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 airflow so that connected total matches fan selection and simulates actual load in the building.
c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
   b. Verify all terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure setpoint to the most energy-efficient setpoint to maintain the optimum system static pressure. Record setpoint and give to controls contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
   b. Re-measure and confirm total airflow is within design.
   c. Re-measure all final fan operating data, rpms, volts, amps, static profile.
   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.

3.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

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 Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 FINAL TEST AND BALANCE REPORT

A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the T&B process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and test results that appear in the reports must be made on site and dated by the AABC technicians or test and balance engineers.

B. The report must be organized by systems and shall include the following information as a minimum:

1. Title Page:
    a. AABC certified company name
    b. Company address
    c. Company telephone number
    d. Project identification number
    e. Location
    f. Project Architect
    g. Project Engineer
    h. Project Contractor
    i. Project number
    j. Date of report
    k. AABC Certification Statement
    l. Name, signature, and certification number of AABC TBE
2. Table of Contents.
3. AABC National Performance Guaranty.
4. Report Summary:
    a. The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.
5. Instrument List:
    a. Type.
    b. Manufacturer.
    c. Model.
    d. Serial Number.
    e. Calibration Date.
6. T&B Data:
    a. Provide test data for specific systems and equipment as required by the most recent edition of the "AABC National Standards."

C. One copy of the final test and balance report shall be sent directly to the design professional of record. Provide five additional copies to the contractor.

3.11 VERIFICATION OF T&B REPORT

A. Final Verification:

1. After testing and balancing is complete and accurately documented in the final report, request that a final verification be made by Engineer.

2. The T&B Agency shall conduct the verification in the presence of Engineer.
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
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 verification, the testing and balancing shall be considered incomplete.

3.12 REVERIFICATION

A. T&B Agency shall recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second verification.

B. If the second verification also fails, Owner/Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.

3.13 ADDITIONAL TESTS

A. Sound Testing

1. After the systems are balanced, read and record sound levels at 10 locations as designated by the Engineer of Record.
2. Instrumentation:
   a. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
   b. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (LEQ).
   c. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 HZ to 8000 HZ.
   d. The accuracy of the sound-testing meter shall be ±1 decibel.
3. Test Procedures
   a. Perform test at the quietest background noise period. Note any cause of unpreventable sound that may affect the test outcome.
   b. Equipment should be operating at design values.
   c. Calibrate the sound-testing meter prior to taking measurements.
   d. Use a microphone suitable for the type of noise levels measured that is compatible with the meter. Provide a windshield for outside or in-duct measurements.
   e. Record a set of background measurements in dB(A), and sound pressure levels in the eight un-weighted octave bands [63 HZ to 8000 HZ (NC)] with the equipment off.
   f. Take sound readings in dB(A), and sound pressure levels in the eight un-weighted octave bands [63 HZ to 8000 HZ (NC)] with the equipment on.
   g. Take readings no closer than 3’ from a wall or from the operating equipment, and approximately 5’ from the floor, with the meter held or mounted on a tripod.

h. For outdoor measurements, move the sound-testing meter slowly and scan the area that has the greatest exposure to the noise source being tested. (This type of reading is generally performed using the A-Weighted scale).

4. Reporting
   a. The report must record: the location, the system tested, the dB(A) reading, and the sound pressure level in each octave band with equipment on and off.
   b. Plot all the sound pressure levels on the NC work sheet, with the equipment on and off.

B. Vibration Testing:

1. After the systems are balanced and the spaces are architecturally complete, read and record vibration levels on all equipment with motor horsepower equal to or greater than 10 hp.
2. Instrumentation:
   a. The vibration meter should be portable, battery-operated, and microprocessor-controlled, with or without a built-in printer.
   b. The meter shall automatically identify engineering units, filter bandwidth, amplitude and frequency scale values.
   c. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
3. Test Procedures:
   a. Verify that the vibration meter calibration date is current before taking readings.
   b. To ensure accurate readings, verify that the accelerometer has a clean, flat surface and is mounted properly.
   c. With the unit running, set up the vibration meter in a safe, secure location. Connect the transducer to the meter with the proper cables. Hold the magnetic tip of the transducer on top of the bearing and measure the unit in mils of deflection. Record the measurement, then move the transducer to the side of the bearing, and record in mils of deflection. Record an axial reading in mils of deflection by holding the nonmagnetic, pointed transducer tip on the end of the shaft.
   d. Change the vibration meter to velocity (inches per second) measurements. Repeat and record the above measurements.
   e. Record the CPM or the RPM.
   f. Read each bearing on the motor and fan as required. Track and record vibration levels from the rotating component through the casing to the base.
4. Reporting
   a. The report must record the location and the system tested.
   b. Include horizontal-vertical-axial measurements for all tests.
   c. Verify that vibration limits follow specifications, or, if not specified, follow the “General Machinery Vibration Severity Chart” or “Vibration Acceleration General Severity Chart” from the AABC National Standards. Acceptable levels of vibration are normally “Smooth” to “Good.”
   d. Include in the report the Machinery Vibration Severity Chart, with conditions plotted.

C. Duct Leakage Testing:

1. Witness the duct pressure testing performed by the mechanical/installing contractor.
2. Verify that proper test methods are used and that leakage rates are within specified tolerances.
3. Report any deficiencies observed.

D. Controls Verification

1. In conjunction with system balancing perform the following:
   a. Work with the temperature control contractor to ensure the system is operating within the design limitations and gain a mutual understanding of intended control performance.
   b. Confirm that the sequences of operation are in compliance with the approved drawings.
   c. Verify that controllers are calibrated and function as intended.
   d. Verify that controller setpoints are as specified.
   e. Verify the operation of lockout or interlock systems.
   f. Verify the operation of all valve and damper actuators.
   g. Verify that all controlled devices are properly installed and connected to the correct controller.
   h. Verify that all controlled devices travel freely and are in the position indicated by the controller: open, closed, or modulating.
   i. Verify the location and installation of all sensors to ensure they will sense only the intended temperatures, humidities, or pressures.
2. Reporting
   a. The report shall include a summary of verifications performed, remaining deficiencies, and any variations from specified conditions.

END OF SECTION 23 05 93

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SECTION 23 07 13

DUCT 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 duct services:

1. Indoor, concealed supply and return air.
2. Indoor, concealed return located in unconditioned space.

B. Related Sections:

1. Section 230719 "HVAC Piping Insulation."
2. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

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

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork 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. 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. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, factory-applied FSK jacket/FSP jacket]. 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. 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).
2. 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. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. 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).
2. 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 MASTICS

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

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
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 (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 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. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. 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 (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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. ASJ Flashing Sealants, and Vinyl 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 (Minus 40 to plus 121 deg C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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."

2.6 FACTORY-APPLIED JACKETS

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

1. ASJ: 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.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 TAPES

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

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.8 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, [Type 304] [or] [Type 316]; 0.015 inch (0.38 mm) thick, [1/2 inch (13 mm)] [3/4 inch (19 mm)] wide with [wing seal] [or] [closed seal].

2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, [1/2 inch (13 mm)] [3/4 inch (19 mm)] wide with [wing seal] [or] [closed seal].
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.
2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    b. Spindle: Copper- or zinc-coated, low-carbon steel/Aluminum, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel/aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.080-inch (2.0-mm) soft-annealed, galvanized 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.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

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

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

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) 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 duct flanges and fittings.

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

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

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

3.4 PENETRATIONS

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

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

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

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

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation

joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Impale insulation over pins and attach speed washers.

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

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment.

5. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

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

6. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.

7. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

8. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.6 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 ductwork, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.7 FINISHES

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

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as 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.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round, and flat-oval, supply-air/return-air duct insulation shall be any of the following:

1. Mineral-Fiber Blanket: 1 inch thick and 1.5 lb./cu. ft. nominal density.
2. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.

B. Concealed, rectangular, round, and flat-oval, outdoor-air duct insulation shall be any of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

2. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

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

D. Exposed, rectangular, supply-air/return-air duct insulation shall be any of the following:

1. Mineral-Fiber Blanket: 1 inch thick and 1.5-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.

END OF SECTION 23 07 13

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SECTION 23 07 19

HVAC 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 HVAC piping systems:

1. Refrigerant liquid, suction and hot-gas piping.
2. Condensate drain piping.

B. Related Sections:

1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

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

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

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

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
2. Sheet Form Insulation Materials: 12 inches (300 mm) square.
3. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).
4. Sheet Jacket Materials: 12 inches (300 mm) square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

C. 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. Board Insulation: ASTM C 552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, with factory-applied FSK jacket/FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

F. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ/FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. 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 (minus 73 to plus 93 deg C).

1. 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).
2. 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. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

1. 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).
2. 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."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. 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).
2. 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."

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. 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).
2. 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."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. 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).
2. 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 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
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 (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
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. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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. 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 (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: 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.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: Color-code jackets based on system.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper/2.5-mil- (0.063-mm-) thick polysurlyn.
   b. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with [wing seal] [or] [closed seal].
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy soft-annealed, galvanized 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.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe.
5. 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.
6. 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.
7. 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.
8. 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.
9. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and

unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

10. 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 (50 mm) 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 (150 mm) 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 (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. 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 MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.9 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 Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPE 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. Fire-suppression piping.
2. Drainage piping located in crawl spaces.
3. Below-grade piping.
4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate Drain:

1. All Pipe Size: Insulation shall be any of the following:
   a. Cellular Glass: 1 inch thick.
   b. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Cellular Glass: 1 inch (25 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. All Exterior Refrigerant Piping (Liquid, Suction, Hot Gas Bypass):

1. Provide min. 1” thick elastomeric insulation with 30 mil PVC jacket.

END OF SECTION 23 07 19

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment in all spaces EXCEPT residential units:

1. Distribution systems, including air distribution (heating and cooling) systems, exhaust systems, air-handling units, etc.
2. Vibration and sound systems, including sound attenuation, vibration isolation devices, seismic restraints.
3. Controls and instrumentation, including BAS.
4. Systems testing and balancing verification, including domestic hot-water circulating systems, supply-air systems, return-air systems, exhaust-air systems.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.03 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital controls.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

E. TAB: Testing, adjusting, and balancing.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration and seismic controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Refrigerant piping.
4. Metal ducts and accessories.
5. Fans.
6. Air-handling units.

1.05 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associate degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:
    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
    b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
    c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
    a. Equipment/instrument identification number.
    b. Planned commissioning application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

D. Test equipment and instrumentation shall meet the following criteria:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout the duration of use on this Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

E. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
2. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
   a. Instrument or tool identification number.
   b. Equipment schedule designation of equipment for which the instrument or tool is required.
   c. Manufacturer, make, model, and serial number.
   d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
3. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
4. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

H. Contributors to the development of construction checklists shall include, but are not limited to, the following:

1. HVAC&R systems and equipment installers.
2. TAB technicians.
3. HVAC&R instrumentation and controls installers.

I. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

J. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

K. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

L. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

M. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

N. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Commissioning tests.
4. Commissioning test demonstrations.

3.02 TAB COMMISSIONING TESTS

A. TAB Verification:

1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. Scope: HVAC&R air systems and hydronic piping systems.
4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
5. Conditions of the Test:
   a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   b. Systems operating in full heating mode with minimum outside-air volume.
   c. Systems operating in full cooling mode with minimum outside-air volume.
   d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
6. Acceptance Criteria:
   a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
   c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.03 AIR-HANDLING SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:

1. Prerequisites: Installation verification of the following:
   a. Volume Control Input Device: Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
   b. Volume Control Output Device: Receiver controller to modulating damper actuator. Set inlet guide vanes to closed position when fan is stopped.
   c. Volume Control Input Device: Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
   d. Volume Control Output Device: Receiver controller to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
   e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
   f. High-Pressure Output Device: Receiver controller to motor starter.
   g. Display the following at the operator's workstation:

1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan speed.

2. Scope: Variable-air-volume supply fan units and associated controls.
   a. Purpose:
      1) Supply-air discharge static pressure control.
   b. Response to excess supply-air discharge static pressure condition.
3. Conditions of the Test:
   a. Minimum supply-air flow.
   b. Midrange Supply-Air Flow: [50 to 60] <Insert number(s)> percent of maximum.
   c. Maximum supply-air flow.
   d. Excess supply-air discharge static pressure.
4. Acceptance Criteria:
   a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
   b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:
   a. Minimum Position Input Device DDC system time schedule.
   b. Output Device: Receiver controller to modulating damper actuator(s).
   c. Heating Reset Input Device: Room thermostat.
   d. Supply-Air Temperature Input Device: Duct-mounted thermostat
   e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted electronic temperature sensors.
   f. Display the following at the operator's workstation:
      1) Mixed-air-temperature indication.
      2) Mixed-air-temperature set point.
      3) Mixed-air damper position.
2. Scope: Air handler with mixed-air control and associated controls.
3. Purpose:
   a. Occupied time control.
   b. Minimum damper position control.
   c. Heating reset control.
   d. Supply-air temperature control.
   e. Cooling reset control.
   f. Unoccupied time control.
4. Conditions of the Test:
   a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
   b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
   c. Heating Reset Control: Create a call for heating.
   d. Supply-Air Temperature Control: Override supply-air temperature set point to a value 2.0 deg F above current supply-air temperature.
   e. Cooling Reset Control: Override outdoor-air temperature to a value that exceeds return-air temperature.
   f. Unoccupied Time Control: Advance to unoccupied schedule time.
   g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend

data for 24-hour periods in which natural conditions require heating reset control, supply-air temperature control, and cooling reset control.
1) Minimum position input device.
2) Heating reset input device.
3) Supply-air temperature input device.
4) Cooling reset input device.

5. Acceptance Criteria:
   a. Occupied Time Control: Mixed-air control is active in occupied mode.
   b. Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.
   c. Heating Reset Control: Controller closes minimum outdoor-air dampers.
   d. Supply Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply-air temperature set point plus or minus 1.0 deg F.
   e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air temperature exceeds return-air temperature.
   f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
   g. Control Data Trend Log: Data verifies control according to sequence of control.

3.04 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units:

1. Prerequisites: Installation verification of the following:
   a. Occupancy Input Device: Occupancy sensor.
   b. Occupancy Output Device: DDC system binary output.
   c. Room Temperature Input Device: Room thermostat.
   d. Room Temperature Output Device: Electronic damper actuators.
   e. Display the following at the operator's workstation:
      1) Room/area served.
      2) Room occupied/unoccupied.
      3) Room temperature indication.
      4) Room temperature set point.
      5) Room temperature set point, occupied.
      6) Room temperature set point, unoccupied.
      7) Air-damper position as percentage open.
2. Scope: Variable-air-volume terminal air units in supply-air systems, and associated controls.
3. Purpose:
   a. Occupancy-dependent room temperature set-point reset.
   b. Room temperature control.
4. Conditions of the Test:
   a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
   b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus 1.0 deg F (0.6 deg C.
   c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until

room temperature is stable at unoccupied set point plus or minus 1.0 deg F (0.6 deg C).

5. Acceptance Criteria:
   a. Temperature Control - Occupied:
      1) Control system status changes from "occupied" to "unoccupied" after the specified time.
      2) Room temperature is stable at occupied set point plus or minus 1.0 deg F (0.6 deg C) within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F (1.1 deg C) during transition.
   b. Temperature Control - Unoccupied:
      1) Control system status changes from "unoccupied" to "occupied" immediately.
      2) Room temperature is stable at unoccupied set point plus or minus 1.0 deg F (0.6 deg C) within 30 minutes of occupancy.

END OF SECTION 23 08 00

SECTION 23 09 23

HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL (NOT USED)

PART 2 - PRODUCTS

2.01 BASE P-C HARDWARE – OPERATOR INTERFACE: SERVER PC EXISTING I-UV 6.0 UPGRADE TO V7.0

A. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.

B. Hardware: Server computer shall consist of the following:

1. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document.

2. The hard disk shall have sufficient memory to store:

a. All required operator workstation software.

b. A DDC database at least twice the size of the delivered system database.

c. One year of trend data based on the points specified to be trended at their specified trend intervals

3. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.

4. Minimum hardware configuration shall include the following:

a. Dual or Quad Core Processor.

b. 6 GB RAM.

c. 500 GB hard disk providing data at 3.0 Gb/sec.

C. Operating Software

1. Web server or workstation shall have an industry-standard professional-grade operating system.

2. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software.

3. Typically, acceptable systems include Microsoft Windows7, Microsoft Vista, Microsoft Windows XP Pro, Windows Server 2003 or 2008.

D. Communication

1. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

2.02 BUILDING CONTROLLERS – BACNET CONTROLLERS: GENERAL PURPOSE

A. Advanced Application Controllers (AAC) shall be a solid state micro-controller with configurable control module with pre-tested and factory configured software specifically designed for regulating building equipment using closed-loop Direct Digital Control and facility management routines. Controllers shall be capable operating in a stand-alone or networked manner, and shall be located where shown on the plans. The controller shall be powered from standard, off-the-shelf, Class II, 24-volt transformers. The controller shall be easily mounted in a standard NEMA 1 type enclosure without special rails or mounting hardware and as local and national code dictates. The controller shall be capable of operating in either a stand-alone mode or as part of a network with an EMS operator's station and other system elements including Product Integrated Controllers (PIC's).

B. BACnet. Advanced Application Controllers (AACs). AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing. AAC shall reside on a BACnet network using the MS/TP or ARCNET Data Link/Physical layer protocol.

C. Custom Programming: The controller shall contain a graphical controller based programming language for creating complex control strategies for specific unique applications. Custom programs shall be retained in controller memory and shall not require a host CPU to operate. All custom programming point data shall be transferable from one controller to another (if networked) directly without an on-line CPU or host computer.

D. Communication:

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

2. Data Sharing. Each AAC shall share data as required with each networked.

E. Environment. Controller hardware shall be suitable for anticipated ambient conditions:

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

F. Memory:
1. The Controller shall have a Non-Volatile Memory providing indefinite storage of application and configuration data.

2. Controller memory shall support operating system, database, and programming requirements.

G. Controller Time: Controller shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions.

H. Stand alone capability. The controller shall be capable of providing all control functions of the HVAC system without the use of a computer:

1. It shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.

I. Networked capability. The controller shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and EMS software program:

1. When networked, occupancy may be established by user interface or occupancy signal from other controller located in network.

J. Scheduling. AAC shall provide the following schedule options as a minimum:

1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.

3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

K. Serviceability:

1. Controller shall have diagnostic LEDs for power, communication, and processor.

2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.

L. Immunity to Power and Noise. AAC shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

M. Input and output devices shall be wired to "quick-connect plug type" terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.

N. Alarm Processing. The controller shall contain a routine to process alarms. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.

O. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

P. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of pre-configured minimum on-time and off-time settings, customized for the specific requirements of the application.

Q. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

R. Inputs. Shall support the following input types as a minimum

1. Dry or pulsed dry contacts
2. 0-5 VDC
3. 0-10 VDC
4. 4-20 mA
5. 10K thermistors
6. 1000-ohm Nickel RTD

S. Outputs. Shall support the following input types as a minimum

1. Discrete types
2. 0-10 VDC analog type
3. 4-20 mA analog type

T. Real-Time Clock. Shall feature and maintain a 365-day hardware clock/calendar with holiday functions.

U. Library of direct digital control routines. The following types of factory tested direct digital control routines shall be provided as a minimum:

1. Indoor/Outdoor Lighting Control
2. Time Schedule with/without override
3. Enthalpy/Analog Comparison
4. Analog Comparison
5. Interlock / Permissive Interlock
6. Fan Control
7. Time Schedule with/without override
8. Unit Heater
9. Constant Volume Air Source control with Demand Controlled Ventilation
10. VAV Air Source control with Demand Controlled Ventilation
11. WSHP Loop Monitor and Pump Control
12. WSHP Loop Cooling - Closed Circuit Tower
13. WSHP Loop Cooling - Open Circuit Tower
14. WSHP Loop Heating
15. Electric Meter with Demand Limit

2.03 FIELD SENSORS: TEMPERATURE, HUMIDITY, CO2, PRESSURE, STATUS, ETC.

A. Temperature Sensors:

1. Space Temperature Sensors: Space Temperature Sensors shall be 10,000-ohm thermistors or resistance temperature detector types with wall plate adapter and blank cover assembly. If so indicated on the plans, the sensor shall include an integral occupancy override button, an RJ11 communications port, and optional space temperature adjustment slide.

2. Duct Temperature Sensors: Duct Temperature Sensors shall be 1000-ohm single point or averaging type as need. Averaging sensors shall be RTDs, or 10,000-ohm averaging thermistors. Single point sensors shall be 5,000 ohm or 10,000-ohm thermistors.

3. Outside Air Sensors: Outside Air Sensor shall 10,000-ohm thermistor, with integral PVC housing and ½" NPT conduit connector.

4. Water Temperature Sensors: Water Temperature Sensors shall be well mounted or pipe-clamp types as specified on the plans. Sensors shall be 10,000-ohm thermistors, or 1,000-ohm RTDs. Locate as shown on the plans, and provide extended neck wells where applicable on insulated pipes.

a. Changeover thermostats shall be 10,000-ohm strap on thermistors with flexible copper plate and screw clamp for externally mounting on the pipe.

B. Humidity Sensors:

1. Space and Duct Relative Humidity Sensors: Space Relative Humidity Sensors shall and have a range of 0-100% RH. The measuring accuracy shall be between 2% and 5% as indicated on the plans over the range of the device.

2. Outdoor Air Relative Humidity Sensors: Outdoor Relative Humidity Transmitters shall be enclosed in a weather-tight junction box and measure outdoor air humidity from 0% to 100% with accuracy between 2% and 5% as needed to fit the application. Transmitters shall not require calibration and shall provide a 2-wire 4-20 mA, 3 wire 0-5 Vdc, or 3 wire 0-10Vdc output signal.

C. CO2 Sensor Sensors

1. Space CO2 Sensor with Temperature Sensors: The wall mounted combination sensors shall contain a space temperature sensor and Carbon Dioxide (CO2) sensor in a single. TheCO2 sensor shall use single-beam absorption infrared diffusion technology and be self-calibrating. The CO2 range shall be 0-2000 PPM with analog outputs of 4-20 ma or 0-10 v. with a power source of 18-30 Vac, 50/60 Hz. The accuracy shall be +/- 100 PPM at 60F to 90F. The sensor shall include an integral occupancy override button, a set point adjustment slidebar, and an RJ14 communication port.

2. Space and Duct CO2 Sensors: The wall mounted, hand held, or duct mounted sensors shall utilize single-beam absorption infrared diffusion technology, and be self-calibrating. The CO2 range shall be 0-2000 PPM with analog outputs of 4-20 ma or 0-10 v. with a power source of 18-30 Vac, 50/60 Hz. The accuracy shall be +/- 100 PPM at 60F to 90F.

D. Pressure Transmitters: Transmitters shall provide accessible zero and span adjustments, and

shall measure gauge or differential pressure of liquids or gases over several operating scales extending from 30 inches vacuum to 2000-psig. The Transmitter shall vary the output current in proportion to the input pressure, and shall operate with a nominal supply voltage of 12 to 32 V dc as needed and provide a 4-20 mA output signal.

E. Current to Pressure Transducers: Current to Pressure Transducers shall convert the 4 to 20ma or 0 to 10 Vdc analog output signal from the controller into a 3-15 PSI pneumatic output. It shall contain a 0-30 PSI manifold gauge indicating actual output air pressure.

F. Flow Transmitters:

1. Transmitters shall be powered by 24 Vdc, and provide a digital display of gpm and totalized flow. Transmitters shall convert a digital flow signal into a 4-20 mA output signal for flow rate indication, and divide the digital input signal into a selectable digital dry or electronic contact pulse output signal for flow totalization indication. Transmitters shall provide excitation voltage for flow sensors and an LED indication of pulse activity.

G. Flow Sensors: Flow Sensors shall utilize differential pressure or a vane to measure water flow and have an operating range with an adjustable setpoint as needed. Water flow types shall be complete with safety shut-off valves and all necessary connections. Flow sensors shall generate a 4-20ma or 0-10Vdc proportional signal as needed.

H. Status Indication: A current sensing or differential pressure device shall provide status indication for fans and pumps.

1. Current Sensing: The current sensing device shall be installed at the motor starter or motor to provide load indication. The device shall consist of a current transformer, a solid state current sensing circuit with adjustable trip point, and a solid state or contact switch. A red light emitting diode (LED) shall indicate the ON OFF status of the unit. The switch shall provide a N.O. contact for wiring back to the General Purpose Controller.

2. Differential Pressure: A differential pressure sensing device shall be installed across the fan or pump and utilize two sensing elements to provide pressure indication. The device shall operate a SPDT switch with adjustable trip point contact for wiring back to the General Purpose Controller.

3. Filter / Status Switches: Filter Switch shall be a differential pressure type, adjustable across the range of the device, with a single pole double throw switch. The range, in inches water column, shall be as indicated on the plans.

4. Float Switches: Float Switches shall be equipped with a stainless steel float, magnetically actuated, and capable of sensing fluids with a specific gravity of 0.7 and higher.

5. High Temperature Detection Thermostats: High Temperature Detection Thermostats shall be of the manual reset type with sensing element arranged to insert into duct or casing and shall be set for 165F. The device shall have double pole, NO, NC contacts for supply fan shutdown and remote alarming.

6. Low Temperature Detection Thermostats: Low Temperature Detection Thermostats shall be of the manual reset, type unless otherwise specified, with sensing element not less than 20 feet long. The device shall have double pole, NO, NC contacts for supply fan shutdown and remote alarming. If alarming is not required, the device shall have a single pole, NC contact.

7. Duct High Pressure Cutout Switches: Duct High Cutout Pressure Switches shall include a manual reset single pole double throw pressure switch with a setpoint range of 1.4 to 5.5 inch water column, tubing and tubing adapters.

8. Start/Stop and Status Relays: Start/Stop and Status Relays shall be designed to plug into a screw terminal-mounting socket. Relays shall be single pole, or double pole as required with double throw contacts rated for required duty. Magnetic Latching Type Control Relay coils shall be activated by a pulsed input and shall maintain condition even during a power failure. A built-in indicator shall show set/reset condition.

I. Power Supplies and Transformers: Power Supplies and Voltage Transformers shall convert 120 Vac primary supply voltage into 24 Vac or 24 Vdc control voltage as needed.

2.04 AUXILIARY CONTROL DEVICES – DAMPERS / ACTUATORS

A. Motorized Control Dampers: Unless specified elsewhere, shall be as follows:

1. Multiple blade dampers shall be parallel or opposed blade type as listed below or as scheduled on the drawings.

2. Single blade round dampers shall have an elliptical blade.

3. Modulating outdoor air and exhaust dampers shall be opposed blade type with blade and side seals.

4. Modulating return air dampers shall be parallel blade type with blade and side seals.

5. Two position shut off dampers may be parallel or opposed blade type with blade and side seals.

6. Damper frames shall be 16 gauge galvanized steel channel or 1/8" extruded aluminum with reinforced corner bracing.

7. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (<2000 fpm). Blades shall not be less than 16guage.

8. Damper shaft bearings shall be as recommended by manufacturer for the application, Oilite or better.

9. All blade edges and top and bottom of the frames shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 cfm/sq. ft at 4" w.c. differential pressure.

10. Individual damper sections shall not be larger than 48" wide x 60" high. Provide a minimum of one damper actuator per section.

11. Dampers shall have exposed linkages.

12. Damper and valve actuators will not produce more than 62 dB when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise

rating of 45 dB(A) with power on or in the running or driving mode.

2.05 VAV CONTROLLERS - RETROFIT

A. VAV zoning system. The zoning system shall be compatible with variable air volume air source and consist of configurable, multiple communicating VAV Air Terminal Controllers. The system shall also include a complete array of input and output devices. The system shall provide full control of HVAC heating and cooling equipment in a multiple zone application. The zoning system shall be capable of operating as a stand-alone system or networked with multiple systems to communicating air source controllers.

1. Zone control. Each zone shall be capable of monitoring space conditions and providing the correct amount of conditioned air to satisfy the space load. Each zone shall be capable of the following:

a. Space temperatures control. To maintain individual heating and cooling set points.

b. Relative Humidity/Air Quality (DCV). Each zone shall be capable of maintaining space relative humidity set point or air quality set point (zone level demand control ventilation) as defined in ASHRAE 62-1989 (including Addendum 62a-1990).

c. Demand coordination. Each zone shall be capable of zone demand data coordination with other zones in the system.

2. Static pressure rest control: The static pressure reset function of the zone system shall automatically reset the central air source's supply-fan static pressure set point (downward) as a function of the zone damper position. This allows the system to automatically make adjustments to the static pressure and optimize performance of the central air source fan. The maximum pressure is determined by the set point configured at the equipment control. The minimum value is determined by the maximum value configured.

3. Air source control. Shall control all associated air source equipment functions, and be capable of stand-alone or networked operation. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and lower energy usage. The Air source shall be capable of zone demand data coordination with the associated zones.

4. System Terminal Modes. Each air terminal mode shall be based on the current air source mode, terminal type, space temperature, and the current temperature set points.

a. Off: No active control of temperature or CFM in the zone

b. Cooling: When the fan is determined to be on, the linkage master zone controller reads the primary air temperature value. If the temperature is less than the average occupied zone temperature, as calculated by the linkage master zone controller, minus 2 degrees F, the mode is determined to be cooling.

c. Night Time Free Cooling (NTFC): The following conditions must be present for free cooling mode:

1) The fan is determined to be on by the linkage master zone controller
2) The average zone temperature value is greater than the average unoccupied

zone cooling temperature set point, as determined by the master zone controller
3) The current time is between 3:00 AM and 7:00 AM
4) The equipment is providing cooling to the system
5) If the above conditions are true, then the mode is determined to be NTFC. This mode is then communicated to all the zone controllers in the system associated.

d. Vent: Temperature requirement of the zone is satisfied. Minimum cooling CFM or damper position is maintained

e. Heat: The zone controller will modulate the primary air damper to maintain the minimum heating CFM, unless the system is configured for VAV Central Heating. If a zone controller is configured for VAV heating, the zone controller will modulate the primary air damper between the minimum and maximum Heating CFM positions

f. Pressurization: The system will bring in as much outside air as possible in order to pressurize the area. This mode is used for smoke control and prevents smoke from entering into an area that is adjacent to an area of smoke. Each zone controller will modulate its damper to provide maximum cooling airflow into the space. If the terminal contains a series fan, the fan will be turned on. If the terminal contains a parallel fan it will be turned off. If the terminal contains auxiliary heat, the heating will be controlled so as to maintain the current heating set point.

g. Evacuation: During the Evacuation mode all terminal fans shall be disabled and all dampers shall close.

5. Air source interface. The zoning system shall be capable of zone demand data coordination with a communicating air source. Setpoints and zone temperature information from the zones shall be shared with the air source controller so that the air source controller's error reduction calculations can determine the proper amount of heating or cooling in order to satisfy the system load.

a. The zoning system shall have the capability of linking up to 128 zones to a single air source and determining system heating and cooling requirements.

b. The zoning system shall be capable of providing a communication check of all associated controls and display device type as well as error conditions.

c. The zoning system shall coordinate and exchange the flowing data as minimum:

1) Average zone temperature
2) Average occupied zone temperature
3) Average occupied and unoccupied heat/cool set points
4) Occupancy status
5) Damper position
6) RH and CO2 values (if applicable)

d. Space temperature and space temperature set points for use by the air source controller shall include a weighted factor, proportional to the size of the zone.

e. Only those zones with valid temperature readings shall be included.

f. The zoning system shall provide periodic updates to the air source.

g. The zoning system shall obtain and support the following air source modes as a minimum:

1) Off
2) Warm-up
3) Cooling
4) Heating
5) Night Time Free Cooling
6) Ventilation
7) Pressurization
8) Evacuation

h. The air source controller shall, through the Air Distribution System, bias its occupancy time schedules to provide optimization routines and occupant override.

1) For those zoning systems that do not include inherent air source interface capacity, each zone shall independently determine the operational mode of the equipment through its associated duct temperature sensor mounted in the supply ductwork. If there is air source controller, then the system will assumed to be always On.

6. Energy Conservation.

a. Load balancing from error reduction calculations that optimize staging.

b. The locking out of mechanical heating or cooling modes based on configurable outside air temperature limits.

c. Staggered start. The system shall intelligently start all equipment in a stagger start manner after a transition from unoccupied to occupied modes as well as power failure to reduce high peak power consumption on start-up.

d. Peak Demand Limiting. Controllers in the system shall have the capability of being overridden by separate heating and cooling Peak Demand Limiting signals. Option/General purpose controller existing on the communications bus shall be able to send a demand limiting broadcast to reduce overall energy consumption and control on and off peak time kW usage

e. Temperature compensated start. The VAV Air Terminal Controller shall be capable of supporting temperature compensated start with the air source. Prior to occupancy the VAV Air Terminal Controllers and Air Source shall work together to provide zone-by-zone temperature compensated conditioning. The air source will track the time required for recovery report the optimal start bias time to the zones prior to each occupied period so that the zone can start conditioning the space prior to occupancy.

7. Abnormal Conditions. The proposed system shall include the ability to detect abnormal conditions, and to react to them automatically. A return to normal conditions shall also generate a return to normal notification and the system shall revert back to its original control scheme before the abnormal condition existed. The following abnormal terminal

conditions shall automatically generate an alarm and the system shall take the following actions:

a. If a space temperature sensor is determined by the VAV Air Terminal Controller to be invalid the controller generates an alarm and disables all local heating or cooling. The controller modulates the damper to the minimum heat, minimum cool, or ventilation position based on the air source mode. Normal operation resumes when the controller detects a valid sensor value.

b. If a relative humidity sensor is determined by the VAV Air Terminal Controller to be invalid, the VAV Air Terminal Controller shall generate an alarm.

c. If an indoor air quality sensor is determined by the VAV Air Terminal Controller to be invalid, the VAV Air Terminal Controller shall generate an alarm, and disable its IAQ algorithm.

d. System level demand coordination. If an air source controller is participating in demand coordination with other zones and loses communication with the associated zones, it shall generate an alarm. Likewise, any zone detecting a communication failure, will generate an alarm.

e. Zone level demand coordination. If the system loses communication with one of the zones associated with that system the zoning system shall remove that zone temperature from its weighted averages. The VAV Air Terminal Controller shall continue to operate in a stand-alone mode.

f. If the zoning system if configured to interface with the air source for zone demand data coordination and that communication is broken, each VAV Air Terminal Controller shall determine the equipment operating mode based on the temperature of the primary air. The air source will be assumed to be always on.

B. VAV Air Terminal Retrofit Controller (ATRC). Defined as Application Specific Controllers (ASC) shall be capable of independent zone control or function as part of the VAV zoning system to achieve performance as specified for zone control.

1. Input and output devices shall be wired to "quick-connect plug type" terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.

2. ATRC shall have an integrated airflow pick-up and transducer, and brushless actuator minimum of 45 in/lbs of torque and be capable of operating zone dampers as well as series and parallel fan powered terminal boxes. The brushless actuator shall separable from the body of the controller for easy mounting and possible replacement.

3. For Dual Duct applications a secondary ATRC shall be available with an integrated airflow pick-up and transducer, and brushless actuator minimum of 45 in/lbs of torque and be capable of operating zone dampers as well as series and parallel fan powered terminal boxes.

4. ATRC shall have the capability to support adjustable minimum and maximum primary CFM control.

5. ATRC shall have the capability to support VAV cooling and relative humidity control

6. ATRC shall have the capability to support IAQ control (Demand Controlled Ventilation CO2 management as per ASHRAE 62) with optional comfort override

7. ATRC shall be capable of controlling supplemental heat or auxiliary heat sources, including fan control, when required at the zone level.

C. Communicating Room Space Temperature (ZS) Temp/RH/CO2

1. Shall have integrated, easy-to-read LCD on display. Able to display space temperature, outside air temperature, heating setpoint, cooling setpoint, and local override (after hours occupancy), time

2. Shall have Precise 10K ohm thermistor with + 0.36ºF (0.2ºC) standard accuracy and less than 0.18ºF (0.01ºC) drift over a ten year span - requires no maintenance or re-calibration

3. Shall allow zone setpoints adjustment by pressing the Warmer or Cooler buttons

4. Shall have a hidden communication port allows a laptop computer or a handheld keypad to commission and maintain the connected equipment easily

5. Shall allow multiple ZS sensors to be daisy-chained to one controller for temperature averaging or high/low select control

6. Shall have ability to mount on a standard 2" x 4" electrical box for easy installation

2.06 ROOFTOP CONTROLLERS, BACNET: SHIP TO FACTORY FOR MOUNTING

A. Rooftop Unit Controller: Rooftop Unit Controller (RTC) shall control all associated HVAC Constant Volume and variable volume rooftop equipment functions, and be capable of stand-alone or networked operation. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and energy usage.

1. RTC must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified.

2. BACnet. RTC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing. RTC shall reside on a BACnet network using the MS/TP or ARCNET Data Link/Physical layer protocol.

3. Communication.

a. Service Port. RTC shall provide a service communication port for connection to a Portable Operator's Terminal.

b. Connection shall be extended to space temperature sensor ports where shown on drawings.

4. Environment.

a. Controller hardware shall be suitable for anticipated ambient conditions.

b. RTC shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

5. Memory.

   a. The Controller shall have a Non-Volatile Memory providing indefinite storage of application and configuration data.

   b. Controller memory shall support operating system, database, and programming requirements.

6. Controller Time: Controller shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions.

7. Stand alone capability. The controller shall be capable of providing all control functions of the HVAC system without the use of a computer.

   a. It shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.

   b. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

8. Networked capability.

   a. RTC The controllers shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and EMS software program.

   b. When networked, RTC occupancy may be established by user interface or occupancy signal from other controller located in network.

9. Scheduling. RTC shall provide the following schedule options as a minimum:

   a. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

   b. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.

   c. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

10. Serviceability.

    a. Controller shall have diagnostic LEDs for power, communication, and processor.

b. Controller in the system shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

11. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

12. Hand held or wall mounted local interface device that allow configuration access shall be password protected with minimum of two levels of security.

    a. Level one shall provide limited access to controller operational parameters

    b. Level two shall provide full access to controller operational and configuration parameters.

13. Alarm Processing. The controller shall contain a routine to process alarms. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.

14. Demand Limiting. Upon receiving network signal the controller shall be capable of providing separate heating and cooling demand control utilizing two independent demand inputs.

15. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.

16. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

17. Keypad. Where specified provide a local keypad and display for each ASC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and ASC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

18. Capacity control shall be based on the use of a conventional thermostat, or programmable thermostat, or alternatively, a constant volume unit may utilize its own internal time clock and setpoints (cooling and heating) coupled with a room sensor for capacity control. The controls shall provide separate occupied and unoccupied cooling and heating setpoints - except if a conventional thermostat is used.

19. To maintain zone temperature at setpoint RTC shall utilize:

    a. Fan control
    b. Up to 2 stages of cooling
    c. Up to 3 stages of heating
    d. MODULATING HEAT AND COOLING
    e. Hot Gas reheat for dehumidification

f. Modulating Fan speed

20. Economizer control. RTC shall provide analog output signal for economizer control.

2.07 OPERATOR INTERFACE EXISTING

A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a standalone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.

B. Operator Interface. Furnish one Web server interface as shown on the system drawings. Operators shall be able to access all necessary operational information in the DDC system via client computer utilizing web browser:

1. Web server shall connect via the LAN and be able to simultaneously serve up controller information to multiple operators connected via LAN with web browsers. Each client web browser connected to server shall be able to access all system information.

2. With the use of a remote SMTP email server the operators interface web server shall be able to notify personnel of an alarm or record information about an alarm in the DDC system.

3. Secondary interface, in addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone and tablet devices. As a minimum, the following capabilities shall be provided through this interface:

a. Secondary interface with screen resolution 1024x768 and above shall be able to provide a full graphical environment as the primary interface.

b. Secondary interface with screen resolution lower than 1024x768 may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:

1) An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.

2) The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.

3) A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any

value within their range.

4) Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system, and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.

C. Web Server Hardware. Furnish one web server with Ethernet port for LAN or direct operator client computer access. The web server shall be capable of communicating to the peer to peer DDC controller network. Any required installation or commissioning software shall be preinstalled on the web server. Installation or commissioning of the web server shall be done through a client computer with a standard web browser.

D. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

E. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out. System shall require user name and password to log in to operator interface.

2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.

3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.

4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.

5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.

6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

F. System Software.

1. Operating System and required software. Web server operator interface shall be a self-contained web server without the need for any type of maintenance.

2. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.

c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins.

G. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard Windows compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each web server shall store internally store a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

3. System Configuration. Operators shall be able to configure the system.

4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

5. Security. System shall require a user name and password to view, edit, add, or delete data.

    a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.

    b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

    c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.

8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server from each workstation or web browser interface.

11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.

12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics.

13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

    a. Standard Reports. Furnish the following standard system reports:

        1) Reports shall be filtered based upon the selected equipment
        2) Alarm Reports

a) Alarm Summary - Current alarms
b) Alarm Sources – List of equipment and associated alarm conditions
c) Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up

3) Schedule Reports
a) Effective Schedules – Displays effective schedules for each equipment
b) Schedule Instances – Displays all schedules entered

4) Security Reports – Maintains audit of all actions taken through user interface
5) Commissioning Reports – Provide equipment checkout status and notes
6) Equipment Reports – Provide reports showing trended points and available network points

b. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.

14. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

15. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

PART 3 - EXECUTION

3.01 EXECUTION

A. Examination

1. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

2. Notify the Owners Representative in writing of conditions detrimental to the proper and timely completion of the work.

B. Installation (General)

1. Install hardware and software in accordance with manufacturer's instructions.

2. Provide all miscellaneous devices, hardware, software, interconnections installation and configuration required to insure a complete operating system in accordance with the sequences of operation and point schedules.

3. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

4. Install equipment, piping, and wiring/raceways parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

C. Location and Installation of Components

1. Locate and install components for easy accessibility; in general, mount 60 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from Owner's representative prior to installation.

2. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.

3. Identify all equipment and panels. Provide permanently mounted tags for all panels.

4. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections; sized to suit pipe diameter without restricting flow.

D. Interlocking and Control Wiring

1. Provide all interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with Specification Division 16 and all national, state and local electrical codes.

2. Provide wire and wiring techniques recommended by equipment manufacturers.

3. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner's representative prior to rough-in.

4. Provide auxiliary pilot duty relays on motor starters as required for control function.

5. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.

6. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed in a neat and inconspicuous manner per local code requirements.

7. When a cable enters or exits a building, a surge suppressor must be installed. The surge suppressor shall be installed according to the manufacturer's instructions.

8. All sensor wiring shall be labeled to indicate the origination and destination of data.

E. Field Services

1. Prepare and start the control system under provisions of this section.

2. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

3. Provide the capability for off-site monitoring. As a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide internet connec-

tion for this service for 1 year or as specified.

4. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

5. Provide the Owners Representative an in warranty maintenance proposal.

F. Training

1. Provide training to the owner in the operation of systems and equipment.

2. Provide basic operator training for a minimum of 3 people on all functions of the Operator Interface unit.

3. Provide training, as required, for up to 16 hours as part of this contract.

G. Demonstration

1. Provide systems demonstration of each sub-system.

2. Demonstrate a complete operating system to Owner's Representative.

3. Provide certificate stating that control system has been tested and adjusted for proper operation.

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SECTION 231123

FACILITY NATURAL-GAS PIPING

1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Pipes, tubes, and fittings.
      2) Piping specialties.
      3) Piping and tubing joining materials.
      4) Valves.
      5) Pressure regulators.

2. PERFORMANCE REQUIREMENTS

   a. Minimum Operating-Pressure Ratings:

      1) Piping and Valves: 100 psig minimum unless otherwise indicated.
      2) Service Regulators: 65 psig minimum unless otherwise indicated.

3. ACTION SUBMITTALS

   a. Product Data: For each type of product indicated.

   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.

4. INFORMATIONAL SUBMITTALS

   a. Welding certificates.

   b. Field quality-control reports.

5. CLOSEOUT SUBMITTALS

   a. Operation and maintenance data.

6. 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.

2 PRODUCTS

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.

b. PE Pipe: ASTM D 2513, SDR 11.

1) PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2) PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3) Anodeless Service-Line Risers: Factory fabricated and leak tested.

a) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
b) Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
c) Aboveground Portion: PE transition fitting.
d) Outlet shall be threaded or suitable for welded connection.
e) Tracer wire connection.
f) Ultraviolet shield.
g) Stake supports with factory finish to match steel pipe casing or carrier pipe.

4) Transition Service-Line Risers: Factory fabricated and leak tested.

a) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b) Outlet shall be threaded or suitable for welded connection.
c) Bridging sleeve over mechanical coupling.
d) Factory-connected anode.
e) Tracer wire connection.
f) Ultraviolet shield.
g) Stake supports with factory finish to match steel pipe casing or carrier pipe.

2. PIPING SPECIALTIES

a. 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.

b. Y-Pattern Strainers:

1) Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2) End Connections: Threaded ends for NPS 2 and smaller.
3) Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4) CWP Rating: 125 psig.

c. 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.

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 complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

4. MANUAL GAS SHUTOFF VALVES

a. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

b. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1) CWP Rating: 125 psig.
2) Threaded Ends: Comply with ASME B1.20.1.
3) Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4) Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5) Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6) Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

c. Bronze Plug Valves: MSS SP-78.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) A.Y. McDonald Mfg. Co.
b) Lee Brass Company.

2) Body: Bronze, complying with ASTM B 584.
3) Plug: Bronze.
4) Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5) Operator: Square head or lug type with tamperproof feature where indicated.
6) Pressure Class: 125 psig.
7) Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8) Service: Suitable for natural-gas service with "WOG" indicated on valve body.

d. 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 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.

5. DIELECTRIC UNIONS

a. Dielectric Unions:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a) WATTS.
b) Wilkins.
c) Zurn Industries, LLC.

2) Description:

a) Standard: ASSE 1079.
b) Pressure Rating: 125 psig minimum at 180 deg F.
c) End Connections: Solder-joint copper alloy and threaded ferrous.

6. 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.

3 EXECUTION

1. OUTDOOR PIPING INSTALLATION

   a. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

   b. Install underground, natural-gas piping buried at least 30 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

      1) If natural-gas piping is installed less than 30 inches below finished grade, install it in containment conduit.

   c. Install underground, PE, natural-gas piping according to ASTM D 2774.

   d. Steel Piping with Protective Coating:

      1) Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
      2) Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
      3) Replace pipe having damaged PE coating with new pipe.

   e. Install fittings for changes in direction and branch connections.

2. VALVE INSTALLATION

   a. Install underground valves with valve boxes.

   b. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

   c. Install anode for metallic valves in underground PE piping.

3. PIPING JOINT CONSTRUCTION

   a. Ream ends of pipes and tubes and remove burrs.

   b. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

   c. Threaded Joints:

      1) Thread pipe with tapered pipe threads complying with ASME B1.20.1.
      2) Cut threads full and clean using sharp dies.
      3) Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
      4) Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
      5) Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

   d. Welded Joints:

1) Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2) Bevel plain ends of steel pipe.
3) Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

e. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

f. 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.

g. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1) Plain-End Pipe and Fittings: Use butt fusion.
2) Plain-End Pipe and Socket Fittings: Use socket fusion.

4. 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.

5. LABELING AND IDENTIFYING

a. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

6. FIELD QUALITY CONTROL

a. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

b. Natural-gas piping will be considered defective if it does not pass tests and inspections.

c. Prepare test and inspection reports.

7. OUTDOOR PIPING SCHEDULE

a. Underground natural-gas piping shall be the following:

1) PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.

b. 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.

c. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

d. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

8. UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

a. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

b. Underground: Bronze plug valves.

9. ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

a. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1) Bronze plug valve.

END OF SECTION 231123

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SECTION 23 13 23

GENERATOR FUELING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Divisions 1, 23, 26, 31 and 32 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Under this Section, the Contractor shall furnish all required labor, materials, equipment, system startups and all required training services for ALL required fueling systems to the emergency generator, as shown on the plans, as specified and/or directed.

1.3 REFERENCES

A. New York State Fire & Building Codes, Mechanical Code of New York State & Fire Code of New York State.

B. ALL Underwriters Laboratory (UL) as determined for fueling storage and equipment.

C. New York State Codes, Rules and Regulations (NYCRR), 6 NYCRR Part 613 Petroleum Bulk Storage.

D. Westchester County Sanitary Code Article XXV Petroleum Bulk Storage.

E. Petroleum Equipment Industry (PEI) current publication #R100-05 UST Standard Practices.

F. Petroleum Equipment Industry (PEI) current publication #R900-08 UST Inspection/Testing Std. Practices.

G. Applicable NFPA 30 & NPFA 30-A Fueling System Standards.

H. Applicable NFPA 110 Standards for Emergency & Standby Power.

I. Applicable NFPA 70 Electrical Standards.

J. UL1316 FRP UST Standards.

K. EPA CFR 280.32 Bio Diesel Fuel Storage.

L. Applicable EPA & CARB (California Air Resources Board) Fueling Components.

1.4 SUBMITTALS & STATEMENTS

A. Manufacturer's Catalog Data:
1. Pipe, access pipe, and fittings
2. Hangers and supports
3. Equipment connectors
4. Associated fueling valves
5. Diesel fuel filtration systems and diesel packaged day tank system, controls and accessories
6. Warning tape
7. Tank risers
8. Transition fittings
9. Secondary containment piping system and sumps
10. Fuel tank monitoring and leak detection equipment and system
11. Underground storage tank and deadman anchor systems

B. Required Manufacturer's Shop and Electrical Layout Drawings/Schematics
1. Underground storage tank and deadman anchor systems
2. Diesel fuel filtration system and diesel packaged day tank system, controls and accessories
3. Fuel tank monitoring and leak detection equipment and system

C. Statements and Certifications
1. Manufacturer's fuel tank and sump current certifications. Must be prequalified prior to bid date.
2. Contractor shall observe all applicable local, state, and federal laws, regulations, and standards. This includes, but is not limited to, all applicable OSHA regulations, 49 CFR Part 192 and 49 CFR Part 195.
3. Installation Documentation:
    a. Completed Warranty Certification Cards & Forms (for all installed equipment as specified)
    b. All Pressure/Air Test Reports (as recommended by Underground Pipe and Fuel Tank Manufacturers in addition to any tests required by state, local, or federal laws, regulations, or statutes)
    c. NYSDEC current leak test reports (underground tank and pipe sumps)
    d. ALL manufacturer's installation manuals, operation and maintenance manuals
    e. ALL manufacturer's pre-installation checklists
    f. Statement from the installer certifying that each UST system component was installed in compliance with Westchester County Sanitary Code Article XXV Petroleum Bulk Storage.
    g. Completed manufacturer's installation checklist for each UST system component showing that the component was installed in accordance with the manufacturer's instructions, as required by the Westchester County Sanitary Code Article XXV Petroleum Bulk Storage.

PART 2 - PRODUCTS

2.1 GENERAL

A. To assure quality of control, ALL fueling systems equipment listed as follows MUST BE supplied by a single source authorized distributor for all equipment listed for a complete system. This system can be obtained by the following company, as well as others.

WildcoPES. Local contact Kevin Henn 201-397-4631 or email kevinhenn@wildcopes.com

Authorized similar suppliers are available and must be submitted 14 days prior to be the bid and approved by the engineer of record.

Distributor must have written authorizations that they are current approved representative of all products and or services as specified below.

All products as specified below are based upon a determination they meet this projects standards of design and comply with all the local, state and federal specifications. Alternate products must be approved 14 days prior to the bid by the design engineer of record.

If additional engineering time is required to make a determination for an alternate product approval, it is up to the individual making request for any compensations incurred.

2.2 UNDERGROUND STORAGE TANK (UST)

A. FRP Tank UST Design – SHAWCOR-XERXES #6FTX6K D/W

The tank shall meet the following criteria:

- Tank Design: Fiberglass reinforced plastic (FRP) tank.
- Tank Design: Double Wall vessel as specified and shown on the drawings.
- Tank size, fittings and accessories shall be as shown on the drawings.
- Tank shall be manufactured with structural ribs which are fabricated as an integral part of the tank wall.
- Tank shall be manufactured with a laminate consisting of resin and glass fiber reinforcement only. No sand/silica fillers or resin extenders shall be used.
- Tank shall be vented to atmospheric pressure.
- Tank shall be capable of handling liquids with specific gravity up to 1.1.
- Tank shall be compatible with liquids identified in the manufacturer’s standard 30-year limited warranty.
- Tank shall bear a permanent stencil, label or plate containing the following information: Manufacturer’s statement that, “This tank conforms with 6 NYCRR Part 613”.

- Tank shall bear name of manufacturer, gallons, and date of manufacture.

B. Loading Conditions

The tank shall meet the following criteria:

- Internal Load - Tank shall be designed to withstand a 5-psig (35 kPa) air-pressure test with a 5:1 safety factor.
- Surface Loads - Tank shall be designed to withstand surface H-20 and HS-20 axle loads when properly installed according to manufacturer's current Installation Manual and Operating Guidelines.
- External Hydrostatic Pressure - Tank shall be designed for 7 feet of overburden over the top of the tank, the hole fully flooded, and a safety factor of 5:1 against general buckling.
- The interstitial space between the tank walls shall be constructed with a glass reinforcement material such as Para beam, which provides a structural bond between the tank walls, while creating a defined interstice that allows for free flow of liquid.
- The interstice of the tank shall be designed to withstand 20-psig (138 kPa) pressure.
- The standard manway shall be flanged, 22 inches (559 mm) I.D. and complete with gaskets, bolts and cover. See drawings for specific information.
- All threaded fittings on the manway or centerline of tank shall be 4IN NPT. See drawings for specific information.
- The tank shall have factory installed 48IN sump containment collars. See drawings for specific information.
- The tank shall have the following FRP TANK SUMP risers and associated adhesives/FRP laminate kits. Bostik sealed or mechanically sealed tank piping sumps will not permitted.
- A #B48142S01 w/all required/recommended installation adhesive/tool packages as recommended by the manufacturer. FRP sump shall carry the manufacturers standard 30-year warranty.
- Anchor straps shall be as supplied by tank manufacturer and designed for a maximum load of 25,000 lbs.
- Galvanized turnbuckles shall be supplied by the tank manufacturer, 2 per strap.
- Prefabricated concrete anchors shall be supplied by the tank manufacturer, designed to the ACI 318 standard, manufactured with 4,000 psi concrete and shall have adjustable anchor points.
- Testing shall be tested according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

- Backfill Materials shall be installed according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

- Installation Tank shall be installed according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

- See drawings for specific and additional information.

2.3 UNDERGROUND STORAGE TANK (UST) MISC. TANK TOP AND EQUIPMENT

A. Grade Level at each Universal Valve Company Tank Sump Access Manhole #108RT-4410-KL (H25 LOAD RATED)

B. Grade Level Universal Valve Company Multipurpose Tank Top Manhole for Tank Stick #72-0504.

C. Grade Level Universal Valve Company Tank Leak Access Manhole #98MW-1810.

D. 4” Overfill Spill Equipment OPW #71S0-4100/#61VA/#633T Package.

E. Vent Line Extractor Valve/Tank Stick Access Pipe Cap Universal Valve Company #V421 4” X 2” & #412 4”.

F. Normal Tank Vent-Universal Valve Company 2” uplow vent #45-20.

See drawings for specific and additional information.

2.4 UNDERGROUND/ABOVEGROUND FUEL & UNDERGROUND VENT PIPE MATERIALS & EQUIPMENT

A. All Fueling Lines: SECON-X Flexible Stainless Steel pipe system #SEC-1 w/end fittings and ZJI pipe entry fittings. All exposed entry fittings MUST BE UV Rated.

B. All Tanks Underground Vent Lines: NOV DUALOY S/W FRP, 2” and include all required couplings/elbows/ends & recommended adhesives.

C. See drawings for specific and additional information. Installation should only be done a certified field installation company for BOTH systems (current required prior to approvals to proceed). Field certifications are permissible and all certification costs should be included.

2.5 PACKAGED DAY TANK FUELING SYSTEM (INSTALLED & PIPED WITHIN GENERATOR ENCLOSURE)

A. Provide, Install, Startup and Train, a packaged design diesel fuel day tank system Simplex Model #STS100. Day tank system shall be complete in all respects in order to provide the prime mover with a reliable, local source of diesel fuel. Day tank shall be for use with main tank and remote fuel delivery system described elsewhere in order to provide an automatic, self-refilling fuel supply system. System shall include the following items:

- One (1) STS Series Double Wall 100 Gallon Tank, UL Labeled. Color: Carolina Vermillion.

- One (1) 2” Vent cap & 2 @ 3" NPT Emergency vent package-FIELD PIPED AND INSTALLED ON SITE OUT SIDE THE GENERATOR ENCLOUSE AS DIRECTED to be included.

- One (1) STS Controller w/Power Available Light, High Alarm, Low Alarm, Leak Alarm Indicator, Pump Running Light, Mode H-O-A Switch, Level Indication, High Fuel Level Emergency Pump Stop Switch and Pump Start/Stop Control and Float switch in secondary containment area w/ alarm.

- One (1) 2 gallon per minute (gpm) pump with lip seal and 1/3HP-115AC-1P-60HZ OPD Motor.

- One (1) gravity return kit.

- See drawings for specific and additional information.

2.6 PACKAGED FUEL CONDITIONER SYSTEM (EXTERIOR MOUNTED)

A. Provide, Install, Startup and Train, Packaged Fuel Conditioner system. Packaged Fuel Conditioner shall be for use with main tank and piped accordingly as required for a filtration, maintenance system for diesel fuel products. This system is for permanent, on site outdoor installation. System shall include the following items:

- One (1) # SFG5C-A, Simplex Smart Filter, Compact, 5GPM. Color: White & Blue. Weatherproof, pad-mountable enclosure, Inlet/outlet ball-type shutoff valves, check valve, pressure differential gauges across pre-filter and final filter-separator, differential pressure switches, high water detector, circulation pump, 40-mesh strainer, 10-micron pre-filter, 5-micron final filter and water separator to 15PPM,5 gallon waste water holding tank, Type 3R control enclosure with cabinet and control heater.

- One (1), 5 gpm cast iron pump with lip seal, UL Listed & 1/2 HP, 230/115V AC, single phase, 60 Hertz motor, TEFC 115/1/60.

- See drawings for specific and additional information.

2.7 UNDERGROUND ELECTRONIC TANK MONITORING AND LEAK DETECTION SYSTEM

A. Provide and install one common remote tank gauging and leak detection system, that can simultaneously monitor product levels, water levels, temperatures, and leaks in up to sixteen tanks. System shall be UL listed and provide intrinsically safe outputs for use in Class 1, Group C & D Hazardous Locations when wired in accordance with manufacturers control drawing. System shall also be Third Party Certified and listed to meet EPA leak detection requirements. System shall include the following items:

- One (1) Omntec Console #OEL8000IIIKP4 w/MODUS via RS-232 communications to successfully connect the system into the building management system (BMS).

controller with 7" color touch screen, printer, (1) RS-232 port, and Ethernet. Accepts up to 4 MTG Series magnetostrictive probes and 16 BX Series leak sensors.

- One (1) Omntec Liquid Level Probe #MTG-72 and to include a 4” cap with integral cable gland, floats, and installation kit. Probe shall use magnetostrictive technology with 6 temperature sensing devices and an accuracy of .01 inches in inventory mode.

- One (1) Omntec BX-PDWF-6 Product Distinguishing sensor for monitoring dry interstice of the double wall FRP UST. Provide 4” Cap/Adaptor Kit at grade for electrical connections.

- Two (2) Omntec BX-PDS Product distinguishing leak sensor for monitoring both tank pipe sumps.

- One (1) Omntec #RAS-1-NYS Overfill Alarm & Acknowledgement with appropriate signage.

- One (1) Omntec #RD7CTS-485 Remote Display (location as to be determined, mounted outside), w/RD-PCK electrical cord kit, ENC-4X-RD7 Nema4X exterior enclosure w/TEM-CE thermostat and HTR-1. This unit to be FACTORY ASSEMBLED by manufacturer. No field assembly to be accepted or approved.

- As required, EC-2/EC-4/EC-6 conductor cables for all equipment as required by the manufacturer guidelines.

- Locate monitoring console where shown on project drawings. See drawings for specific and additional information.

PART 3 - EXECUTION

3.1 Underground Storage Tank, Equipment and Piping

A. Tank and piping systems shall be installed in strict accordance with the manufacturer’s installation instructions and as indicated and specified herein. Handle tank during transportation and while lifting in such a manner as to prevent damage to tank.

B. The tank shall be tested for tightness by the manufacturer prior to delivery, and an air (pneumatic tightness) test of the primary tank shall be conducted prior to tank installation in accordance with the manufacturer's instructions. Inspection of the outer wall of the tank shall be conducted in accordance with the manufacturer’s instructions for any signs of leaks.

C. Care shall be taken during installation that foreign matter is not introduced into excavation or backfill. The bottom of the excavation shall be covered with clean pea stone to depth shown on drawings suitably graded and leveled. Before placing the tank in the excavation, all dirt clods and similar foreign matter shall be cleaned from the tank as required by the manufacturer to prevent any voids when backfilling.

D. Equipment to lift the tank shall be of adequate size to lift and lower the tank without dragging and dropping to ensure no damage to the tank. Tank shall be carefully lifted and lowered by use of cables or chains attached to the lifting lugs provided. A spreader bar shall be used where

necessary per the manufacturer's instructions. Under no circumstances shall chains or slings be used around the tank shell.

E. Tank shall be inspected prior to installation to verify that no damage to the tank has occurred. Any damage must be repaired to new or better condition by a manufacturer approved repair technician.

3.2 Signage

A. Signage: All warning and safety signage shall be provided and constructed in compliance with NFPA Chapters 30 & 30A and New York State Fire Code Chapters 50 and 57, and any other local, State or Federal requirements. Signage shall be metal backed construction, permanently mounted and of the color and sizes dictated by the applicable code and regulation.

3.3 NYSDEC Required Labels on Tank (to be affixed directly on tank or on a sign for USTs) for the following:

A. Color code fill port in accordance with API and NYSDEC for product stored.

B. Label tank with unique tank identification number as listed on the NYSDEC Petroleum Bulk Storage Registration on the tank and at the gauge.

C. Label tank with Design Capacity and Working Capacity at the tank gauge and fill port. Include a conversion chart from depth of product (in inches and feet) to gallons.

D. Label tank with product stored.

E. Provide tag permanently affixed to fill port that includes the identification number as listed on the NYSDEC Petroleum Bulk Storage Registration, tank Design and Working Capacity, type of product stored, and date of installation. Provide an identical second replacement tag to be provided to the Owner. This information shall also be provided on signage installed at the high level alarm on the building.

F. Provide a laminated, tank specific conversion chart from depth of product (in inches and feed) to gallons, and Product Stored.

3.4 Fuel Storage Monitoring Equipment

A. Install all monitoring equipment in strict accordance with the manufacturer's recommendations. Installation of the monitoring equipment shall be conducted by a manufacturer certified technician. Electrical wiring and connections shall be in accordance with Division 26 of the specifications. Following installation, programming, troubleshooting, and startup of installed systems, provide a minimum of 8 hours of training for the operation of tank monitor system by factory authorized technicians.

3.5 Equipment Start-Up & Training Services

A. The Contractor shall start up and operate the new equipment systems under direct responsibility and supervision of the manufacturer, and in the presence of the Owner's representative. The Contractor shall provide all labor, equipment and materials that are required to facilitate the new equipment start-up and initial operation. The Contractor, under the direction of the respective manufacturer's representative, shall perform all work of placing into operation all equipment systems provided by him, except as specifically noted otherwise. Make all adjustments to equipment that are necessary to assure proper operation as instructed by the manufacturer of the equipment. Following successful installation, programming, troubleshooting, and startup of installed systems, provide a minimum of 8 hours of training for the operation of tank monitor system, packaged day tank system and packaged filtration systems by factory authorized technicians. Both startup and training services to be performed by the same company.

3.6 WARRANTY

A. All fuel storage systems equipment shall be warranted for a period of not less than one (1) year from acceptance date, all as per manufacturer's standard warranty policies.

B. Fuel storage tank shall be a limited 30-year warranty as per the current standard warranty policy.

END OF SECTION 23 13 23

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SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

B. Related Sections include the following:

1. Division 7 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire barriers.
2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe supports and installation requirements.
3. Division 23 Section "Mechanical Identification" for labeling and identifying refrigerant piping.

1.3 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

1. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX; "Welding and Brazing Qualifications."

B. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

D. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

1.5 COORDINATION

A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Refrigerants:
   a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
   b. DuPont Company; Fluorochemicals Div.
   c. Elf Atochem North America, Inc.; Fluorocarbon Div.
   d. ICI Americas Inc./ICI KLEA; Fluorochemicals Bus.
2. Refrigerant Valves and Specialties:
   a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
   b. Danfoss Electronics, Inc.
   c. Emerson Electric Company; Alco Controls Div.
   d. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: Type L (ASTM B 88M, Type B).

B. Annealed-Temper Copper Tube: Type L (ASTM B 88M, Type B).

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver) or BAg-2 (silver)

F. Flexible Connectors: 500-psig (3450-kPa) minimum operating pressure; seamless tin-bronze core, high-tensile bronze-braid covering, and solder-joint end connections; dehydrated, pressure tested, minimum 7 inches (180mm) long

2.3 VALVES

A. Diaphragm Packless Valves: 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature; globe design with straight-through or angle pattern; forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.

B. Packed-Angle Valves: 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, and with solder-end connections.

C. Check Valves Smaller Than NPS 1 (DN 25): 400-psig (2760-kPa) operating pressure and 285 deg F (141 deg C) operating temperature; cast-brass body, with removable piston, polytetrafluoroethylene seat, and stainless-steel spring; globe design. Valve shall be straight-through pattern, with solder-end connections.

D. Check Valves, NPS 1 (DN 25) and Larger: 400-psig (2760-kPa) operating pressure and 285 deg F (141 deg C) operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained polytetrafluoroethylene seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.

E. Service Valves: 500-psig (3450-kPa) pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.

F. Solenoid Valves: Comply with ARI 760; 250 deg F (121 deg C) temperature rating and 400-psig (2760-kPa) working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch (16-GRC) conduit adapter and 24/120-V.

G. Pressure-Regulating Valves: Comply with ARI 770; pilot operated, forged brass or cast bronze, stainless-steel bottom spring, pressure-gage tappings, 24-V dc standard coil, and wrought-copper fittings for solder-end connections; suitable for refrigerant specified.

H. Pressure-Regulating Valves: Comply with ARI 770; direct acting, brass; with pilot operator, stainless-steel diaphragm, standard coil, and solder-end connection; suitable for refrigerant specified.

I. Pressure Relief Valves: Straight-through or angle pattern, brass body and disc, neoprene seat, and factory sealed and ASME labeled for standard pressure setting.

J. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended

by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

K. Hot-Gas Bypass Valve: Pulsating-dampening design, stainless-steel bellows and polytetrafluoroethylene valve seat; adjustable; sized for capacity equal to last step of compressor unloading; with solder-end connections.

2.4 REFRIGERANT PIPING SPECIALITIES

A. Straight- or Angle-Type Strainers: 500-psig (3450-kPa) working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches (30 mm), 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.

B. Moisture/Liquid Indicators: 500-psig (3450-kPa) maximum working pressure and 200 deg F (93 deg C) operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.

C. Replaceable-Core Filter-Dryers: 500-psig (3450-kPa) maximum working pressure; heavy gage protected with corrosion-resistant-painted steel shell, flanged ring and spring, ductile-iron cover plate with steel cap screws; wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets and the following:

1. Filter Cartridge: Pleated media with integral end rings, stainless-steel support, ARI 730 rated for capacity.
2. Filter-Dryer Cartridge: Pleated media with solid-core sieve with activated alumina, ARI 730 rated for capacity.
3. Wax Removal Cartridge: Molded, bonded core of activated charcoal and desiccant with integral gaskets.

D. Permanent Filter-Dryer: 350-psig (2410-kPa) maximum operating pressure and 225 deg F (107 deg C) maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

E. Mufflers: 500-psig (3450-kPa) operating pressure, welded-steel construction with fusible plug; sized for refrigeration capacity.

2.5 RECEIVERS

A. Receivers, 6-Inch (150-mm) Diameter and Smaller: ARI 495, UL listed, steel, brazed, 400-psig (2760-kPa) pressure rating, with tappings for inlet, outlet, and pressure relief valve.

B. Receivers Larger Than 6-Inch (150-mm) Diameter: ARI 495, welded steel, tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII; 400-psig (2760-kPa) pressure rating, with tappings for liquid inlet and outlet valves, pressure relief valve, and liquid-level indicator.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground, within Building: Type L (Type B) drawn-copper tubing.

3.2 VALVE APPLICATIONS

A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor, for gage taps at hot-gas bypass regulators, on each side of strainers.

B. Install check valves in compressor discharge lines and in condenser liquid lines on multiple condenser systems.

C. Install packed-angle valve in liquid line between receiver shutoff valve and thermostatic expansion valve for system charging.

D. Install diaphragm packless or packed-angle valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.

E. Install a full-sized, three-valve bypass around each dryer.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve.

1. Install solenoid valves in horizontal lines with coil at top.
2. Electrical wiring for solenoid valves is specified in Division 26 Sections. Coordinate electrical requirements and connections.

G. Install thermostatic expansion valves as close as possible to evaporator.

1. If refrigerant distributors are used, install them directly on expansion-valve outlet.
2. Install valve so diaphragm case is warmer than bulb.
3. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
4. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install pressure-regulating and pressure relief valves as required by ASHRAE 15. Pipe pressure relief valve discharge to outside.

3.3 SPECIALTY APPLICATIONS

A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.

B. Install strainers immediately upstream from each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.

C. Install strainers in main liquid line where multiple expansion valves with integral strainers are used.

D. Install strainers in suction line of steel pipe.

E. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.

F. Install pressure relief valves on ASME receivers; pipe discharge to outdoors.

G. Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.

H. Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve.

I. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

J. Install receivers, sized to accommodate pump-down charge, on systems 5 tons (17.5 kW) and larger and on systems with long piping runs.

K. Install flexible connectors at or near compressors.

3.4 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Basic piping installation requirements are specified in Division 23 Section "Common Work Results for HVAC."

C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

F. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

G. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

H. Install bypass around moisture-liquid indicators in lines larger than NPS 2 (DN 50).

I. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.

J. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

K. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

L. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe rollers for multiple horizontal runs 20 feet or longer, supported by a trapeze.
4. Spring hangers to support vertical runs.

M. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8 (DN 18): Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1 (DN 25): Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2 (DN 50): Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches; minimum rod size, 3/8 inch.

N. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 84 inches; minimum rod size, 1/4 inch.
2. NPS 3/4 (DN 20): Maximum span, 84 inches; minimum rod size, 1/4 inch.
3. NPS 1 (DN 25): Maximum span, 84 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/2 (DN 40): Maximum span, 108 inches; minimum rod size, 3/8 inch.
5. NPS 2 (DN 50): Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2 (DN 65): Maximum span, 11 feet; minimum rod size, 3/8 inch.

O. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

A. Braze joints according to Division 23 Section "Common Work Results for HVAC."

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.6 FIELD QUALITY CONTROL

A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.

1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.
    a. System shall maintain test pressure at the manifold gage throughout duration of test.
    b. Test joints and fittings by brushing a small amount of soap and glycerine solution over joint.
    c. Fill system with nitrogen to raise a test pressure of 150 psig (1035 kPa) or higher as required by authorities having jurisdiction.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of the conditioned air or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Check compressor oil level above center of sight glass.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves, except bypass valves that are used for other purposes.
4. Check compressor-motor alignment and lubricate motors and bearings.

3.8 CLEANING

A. Before installing copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

B. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

3.9 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter-dryer after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION 23 23 00

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SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2500 Pa). Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Single-wall round spiral-seam ducts and formed fittings.
3. Double-wall, round spiral-seam ducts and formed fittings.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 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.

B. Changes to layout or configuration of duct system must be specifically approved in writing by Architect.

C. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Welding certificates.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:
   a. CertainTeed Corp.; Insulation Group.
   b. Johns Manville International, Inc.
   c. Knauf Fiber Glass GmbH.
   d. Owens Corning.
   e. Or approved equal.
2. Materials: ASTM C 1071; surfaces exposed to air stream shall be coated to prevent erosion of glass fibers.
   a. Thickness: 1 inch.
   b. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner

when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- (23-kg-) tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch (3 mm) into air stream.
3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.4 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.6 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Nexus Inc.
   c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Lockformer.
2. Duct Size: Maximum 30 inches (750 mm) wide and up to 2-inch wg (500-Pa) pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of non-braced panel area unless ducts are lined.

2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. 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.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).

G. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

H. 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:

1. Fan discharges.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

I. Terminate inner ducts with build outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build outs (metal hat sections) or other build out means are optional; when used, secure build outs to duct walls with bolts, screws, rivets, or welds.

2.8 ROUND DUCT AND FITTING FABRICATION (WHERE INDICATED ON DRAWINGS)

A. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate exhaust air ducts of aluminum according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

1. Manufacturers:
   a. McGill AirFlow Corporation.
   b. SEMCO Incorporated.

B. Duct Joints:

1. Ducts up to 20 Inches (500 mm) in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches (535 to 1830 mm) in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
   a. Manufacturers:
      1) Ductmate Industries, Inc.

2) Lindab Inc.

C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):
   a. Ducts 3 to 36 Inches (75 to 915 mm) in Diameter: 0.034 inch (0.85 mm).
   b. Ducts 37 to 50 Inches (940 to 1270 mm) in Diameter: 0.040 inch (1.0 mm).
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg (500 to 2500 Pa):
   a. Ducts 3 to 26 Inches (75 to 660 mm) in Diameter: 0.034 inch (0.85 mm).
   b. Ducts 27 to 50 Inches (685 to 1270 mm) in Diameter: 0.040 inch (1.0 mm).
4. Round Elbows 8 Inches (200 mm) and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
5. Round Elbows 9 through 14 Inches (225 through 355 mm) in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Die-Formed Elbows for Sizes through 8 Inches (200 mm) in Diameter and All Pressures 0.040 inch (1.0 mm) thick with 2-piece welded construction.
7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
8. Pleated Elbows for Sizes through 14 Inches (355 mm) in Diameter and Pressures through 10-Inch wg (2500 Pa): 0.022 inch (0.55 mm).

2.9 DOUBLE-WALL DUCT AND FITTING FABRICATION (WHERE INDICATED ON DRAWINGS)

A. Manufacturers:

1. Lindab Inc.
2. McGill AirFlow Corporation.
3. SEMCO Incorporated.
4. Or approved equal.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches (50 mm) longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch- (25-mm-) thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components and reduce outer shell diameter to inner duct diameter.
   a. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
3. Solid Inner Ducts: Refer to drawings for areas with solid inner walls. Use the following sheet metal thicknesses and seam construction:
   a. Ducts 3 to 8 Inches (75 to 200 mm) in Diameter: 0.019 inch (0.5 mm) with standard spiral-seam construction.
   b. Ducts 9 to 42 Inches (225 to 1070 mm) in Diameter: 0.019 inch (0.5 mm) with single-rib spiral-seam construction.
4. Perforated Inner Ducts: Refer to drawings for areas with perforated inner walls. Fabricate with 0.028-inch-0.7-mm- thick sheet metal having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:
   a. Ducts 3 to 34 Inches (75 to 865 mm) in Diameter: 0.028 inch (0.7 mm).
   b. Ducts 35 to 58 Inches (890 to 1475 mm) in Diameter: 0.034 inch (0.85 mm).
2. Perforated Inner Ducts: Fabricate with 0.028-inch- (0.7-mm-) thick sheet metal having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Return Ducts (Negative Pressure): 2-inch wg.
2. Exhaust Ducts (Negative Pressure): 2-inch wg.

B. All ducts shall be galvanized steel except exhaust air duct for chemical fume hood shall be aluminum construction.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round ducts in lengths not less than 12 feet (3.7 m) unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."

O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

Q. Paint interiors of metal ducts, that do not have duct liner, for 24 inches (600 mm) upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.

B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (500 Pa) (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg (500 to 2500 Pa).

4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.7 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct accessories.

F. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

3.8 CLEANING EXISTING SYSTEMS

A. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Remove and reinstall ceiling sections to gain access during the cleaning process.

B. Mark position of dampers and air-directional mechanical devices before cleaning and restore to their marked position on completion.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.
8. Submit photo documentation indicating effectiveness of duct cleaning, before and after cleaning.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct accessories.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide operative drainage system for wash down procedures.
6. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and re-inspect ducts.

G. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION 23 31 13

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SECTION 23 31 16

NONMETAL DUCTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.

B. Types of non-metal ductwork required for this project include the following:

1. Textile Air Dispersion Products.

1.2 QUALITY ASSURANCE

A. Building Codes and Standards

1. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518.
2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.

B. Design and Quality Control

1. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length; and suspension. Parameters for design, including maximum air temperature, velocity, pressure and textile permeability, shall be considered and documented.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.

B. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories for both NFPA 90-A and UL 2518.

C. Provide detailed drawings confirming configuration of Textile Dispersion System (diameter, lengths, airflow, pressure, and textile permeability).

D. Provide detailed installation instructions for components to be installed.

E. Provide warranty and maintenance documentation.

1.4 WARRANTY

A. Manufacturer must provide a 10 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect textile air dispersion system and Hoops (IHS) components from damage during shipping, storage, and handling.

B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. DuctSox® Corporation
Phone: (866) DUCTSOX or (563) 588-5300
FAX: (866) 398-1646 or (563) 588-5330
www.DuctSox.com

2.2 TEXTILE AIR DISPERSION SYSTEM

A. Hoops (IHS) System: Air diffusers shall be constructed with internal retention system.

1. System shall consist of an internal 360 degree hoop system, spaced 5’ on center.
2. System shall be installed with a one row suspension system located 1.5” above top-dead-center of the textile system.
3. System attachment to cable or U-Track shall be made using Gliders spaced 12 inches.
4. Available for diameters from 8” – 48”.
5. One row suspension options (must specify if multiple on same project)
    a. Cable suspension hardware to include cable, eye bolts, thimbles, cable clamps, and turnbuckle(s) as required.
        i. Cable suspension options (must specify if multiple on same project)
            a. Galvanized steel cable
            b. Stainless steel cable
            c. Impregnated steel cable (required for natatorium applications)
        ii. Support lengths available in 5’(standard), 10’, 15’, and 30’.
    b. U-Track suspension hardware to include 8’ sections of aluminum track, aluminum splice connectors, track endcaps and vertical cable support kits – consisting of a length of cable with cable connectors. Radius aluminum track must be included for all horizontal/flat radius sections.
        i. U-Track suspension options (must specify if multiple on same project)
            a. Galvanized steel cable
            b. Stainless steel cable
            c. Impregnated steel cable (required for natatorium applications)
        ii. Support lengths available in 5’(standard), 10’, 15’, and 30’
    c. U-Track Surface Mount hardware to include 8’ sections of aluminum track, aluminum splice connectors, track endcaps, and U-Track suspension attachments. Radius aluminum track must be included for all horizontal/flat radius sections.
        i. U-Track Surface Mount suspension options (must specify if multiple on same project)
            a. U-Clip spring attachment
            b. U-Clip spring attachment with T-Bar clip and rivet

B. Textile

1. Sedona-Xm

a. Textile Construction: Filament/filament twill polyester treated with a machine washable anti-microbial agent by the fabric manufacturer, fire retardant in accordance with UL 2518. Non-linting filament yarn to meet the requirements of ISO Class 3 environment.
b. Air Permeability: 2 (+2/-1) CFM/ft2 per ASTM D737, Frazier
c. Weight: 6.8 oz. /yd2 per ASTM D3776
d. Warranty: 10 years
e. Refer to floorplans for nozzle/outlet locations and angles.

2. Textile Color
   a. Coordinate with Owner/Project Manager/Architect

C. Textile System Fabrication Requirements

1. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips along the length of the system.
2. Integrated air dispersion shall be specified and approved by manufacturer. (select only those that apply)
   a. Linear Vents
      i. Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
      ii. Size of vent openings and location of linear vents to be specified and approved by manufacturer. Refer to drawings for layout and orientation.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
4. Inlet connection includes zipper for easy removal / maintenance.
5. Lengths to include required intermediate zippers as specified by manufacturer.
6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
7. End cap includes zipper for easy maintenance.
8. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

D. Design Parameters

1. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.
2. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
3. System overall design; diameter, length, airflow, operating static pressure and dispersion shall be designed or approved by the manufacturer.
4. Do not use textile diffusers in concealed locations.
5. Use textile air dispersion systems only for positive pressure air distribution components of the mechanical ventilation system.

PART 3 - INSTALLATION

3.1 INSTALLATION OF TEXTILE AIR DISPERSION SYSTEM

A. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

3.2 CLEANING AND PROTECTION

A. Clean air handling unit and ductwork prior to the DuctSox system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

B. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.

C. If DuctSox systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION 23 31 16

SECTION 23 33 00

DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Special fittings.
2. Manual-volume damper installations.
3. Fire-damper and smoke-damper installations, including sleeves and duct-mounting access doors.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 (Z180)/G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. 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 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
4. Greenheck.
5. Penn Ventilation Company, Inc.
6. Ruskin Company.
7. Vent Products Company, Inc.

B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.

D. Blades: 0.050-inch thick aluminum sheet.

E. Blade Seals: Vinyl/Neoprene.

F. Blade Axles: Nonferrous/Galvanized steel.

G. Tie Bars and Brackets: Aluminum/Galvanized steel.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow Corporation.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Multiple opposed-blade design as indicated, standard leakage rating, with linkage outside air stream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050 inch thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings: Oil-impregnated bronze.
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

D. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
6. McGill AirFlow Corporation.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.

B. General Description: AMCA-rated, parallel blade design; minimum of 0.1084-inch thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch thick, galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.

3. Provide closed-cell neoprene edging parallel-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.6 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. CESCO Products.
3. Greenheck.
4. McGill AirFlow Corporation.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Prefco Products, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 2 hours.

D. Frame: Curtain type with blades outside air stream; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 165 deg F rated.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch wide, single vane, curved blades of galvanized sheet steel set 3/4 inch o.c; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Duro Dyne Corp.
   c. METALAIRE, Inc.
   d. Ward Industries, Inc.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. American Warming and Ventilating.
   b. CESCO Products.
   c. Ductmate Industries, Inc.
   d. Flexmaster U.S.A., Inc.
   e. Greenheck.
   f. McGill AirFlow Corporation.
   g. Nailor Industries Inc.
   h. Ventfabrics, Inc.
   i. Ward Industries, Inc.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:
   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two sash locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Flexmaster U.S.A., Inc.
2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory 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. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 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 pilot 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 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install back draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers, turning vanes, and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.

I. Label access doors according to Division 23 Section "Mechanical Identification."

J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

K. Connect diffusers to low pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

L. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

M. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00

SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: For each product.

1. Backward-inclined centrifugal fans.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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. Capacities and Characteristics:

1. Refer to schedules for information.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings
   a. Greenheck
   b. Cook
   c. Penn Barry
   d. Approved Equal
3. Description:
   a. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
   b. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
   c. Factory-installed and -wired disconnect switch.
4. Housings:
   a. Formed panels to make curved-scroll housings with shaped cutoff.
   b. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   c. Split housings in first subparagraph below are an optional configuration.
   d. Horizontally split, bolted-flange housing.
   e. Spun inlet cone with flange.
   f. Outlet flange.

5. Backward-Inclined Wheels:
   a. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
   b. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.
6. Shafts:
   a. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
   b. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   c. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
7. Pre-lubricated and Sealed Shaft Bearings:
   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours
   c. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours.
8. Grease-Lubricated Shaft Bearings:
   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours.
   c. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours.
9. Grease-Lubricated Shaft Bearings:
   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours.
   c. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours.
10. Belt Drives:
    a. Factory mounted, with adjustable alignment and belt tensioning.
    b. Service Factor Based on Fan Motor Size.
    c. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
    d. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
    e. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
    f. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
    g. Motor Mount: Adjustable for belt tensioning.
11. Accessories:
    a. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
    b. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
12. Companion Flanges: Rolled flanges for duct connections of same material as housing.
13. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
14. Inlet Screens: Grid screen of same material as housing.

15. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
16. Spark-Resistant Construction: AMCA 99.
17. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
18. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts."

1. Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
2. Install units with clearances for service and maintenance.
3. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 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. 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.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.
11. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
12. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 23 34 16

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SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units.
2. Casing liner.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment [seismic restraints] and vibration isolation.

C. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Include design calculations [including analysis data signed and sealed by the qualified professional engineer responsible for their preparation] for selecting hangers and supports [and seismic restraints].

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
   a. Instructions for resetting minimum and maximum air volumes.
   b. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Powered-Unit Filters: Furnish [one] <Insert number> spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.040-inch- (1.0-mm-) thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
2. Damper Position: Normally open.

E. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Electric Damper Actuator: 24 V, powered open, spring return.
2. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

F. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.
2. System-powered, wall-mounted thermostat.

G. Control Sequences:

1. Occupied:
   a. In a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
   b. In a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
2. Unoccupied:
   a. Damper closes to minimum maximum setting.

2.3 CASING LINER

A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Minimum Thickness: 1 inch (25 mm).

a. Maximum Thermal Conductivity:
1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.

2. 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 by an NRTL and registered by the EPA for use in HVAC systems.
3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
a. Adhesive VOC Content: 80 g/L or less.
b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, [coil type] and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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 and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.3 CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

C. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

SECTION 23 37 13

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DIFFUSERS AND REGISTERS

A. Manufacturers:

1. Titus
2. Anemostat; a Mestek Company
3. Krueger
4. Approved Equal

B. Refer to drawings for types of registers, diffusers and grilles in this project. Model #’s and Mfr’s names have been provided on the drawings.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

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SECTION 23 38 13

COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes Type I and Type II commercial kitchen hoods.

1.3 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type I Hood: A hood designed for grease exhaust applications.

D. Type II Hood: A hood designed for heat and steam removal and for other non-grease applications.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Standard hoods.
2. Filters/baffles.
3. Fire-suppression systems.
4. Lighting fixtures.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Shop Drawing Scale: 1/4 inch = 1 foot.
2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
5. Show water-supply and drain piping connections.

6. Show control cabinets.
7. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
8. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
9. Design Calculations: Calculate requirements for selecting seismic restraints.
10. Wiring Diagrams: Power, signal, and control wiring.
11. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.
    a. Piping Diagram Scale: 1/4 inch = 1 foot.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Coordination Drawing Scale: 1/4 inch = 1 foot.
2. Suspended ceiling assembly components.
3. Structural members to which equipment will be attached.
4. Roof framing and support members for duct penetrations.
5. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Moldings on hoods and accessory equipment.

B. Welding certificates.

C. Manufacturer Seismic Qualification Certification: Submit certification that commercial kitchen hoods, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.7 COORDINATION

A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish one complete set(s) of grease filters/baffles.

PART 2 - PRODUCTS

2.1 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304.

1. Minimum Thickness: 0.037 inch.
2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
   a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
4. Exposed Surfaces: ASTM A 480/A 480M, No. 3 finish (intermediate polished surface).
5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Zinc-Coated Steel Shapes: ASTM A 36/A 36M, zinc coated according to ASTM A 123/A 123M requirements.

C. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.
2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

D. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch (3-mm) thickness that does not chip, flake, or blister.

E. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.2 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

J. Fabricate seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."

K. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

L. Fabricate enclosure panels to ceiling and wall as follows:

1. Fabricate panels on all exposed side(s) with same material as hood and extend from ceiling to top of hood canopy and from canopy to wall.
2. Wall Offset Spacer: Minimum of 3 inches (75 mm).
3. Wall Shelves and Overshelves: Fabricate according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," with minimum 0.0625-inch- (1.58-mm-) thick, stainless-steel shelf tops.

2.3 TYPE I EXHAUST HOOD FABRICATION

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Captive Air
2. Greenheck.
3. Approved equal

C. Weld all joints exposed to grease with continuous welds and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.

1. Fabricate hoods according to NSF 2, "Food Equipment."
2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
3. Hoods shall be designed, fabricated, and installed according to NFPA 96.
4. Include access panels as required for access to fire dampers and fusible links.
5. Duct Collars: Minimum 0.0598-inch-thick steel at least 3 inches long, continuously welded to top of hood and at corners. Fabricate a collar with a 0.5-inch- wide duct flange.
6. Duct-Collar Fire Dampers: Collar and damper shall comply with UL 710 testing and listing required for the entire hood.
    a. Collar: Minimum 0.0598-inch- thick stainless steel, at least 3 inches long, continuously welded to top of hood and at corners. Fabricate a collar with a minimum 0.5-inch-wide duct flange.
    b. Blades: Minimum 0.1046-inch-thick stainless steel, counterbalanced to remain closed after actuation.

c. Blade Pivot and Spring: Stainless steel.
d. Fusible Link: Replaceable, 212 deg F rated.

7. Makeup Air Fire Dampers: Labeled, according to UL 555, by a testing agency acceptable to authorities having jurisdiction.
   a. Fire Rating: 1-1/2 hours.
   b. Frame: SMACNA [Type B, with blades in airstream; fabricated with roll-formed, galvanized steel; with mitered and interlocking corners.
   c. Blades: Roll-formed, interlocking or folded, minimum 0.034-inch-thick, galvanized-steel sheet.
   d. Horizontal Dampers: Include a blade lock and stainless-steel closure spring.
   e. Fusible Link: Replaceable, 165 deg Frated.

D. Hood Configuration: Exhaust and makeup air.

1. Makeup air shall be introduced through front of canopy through perforated diffusers.

E. Hood Style: Wall-mounted canopy.

F. Filters/Baffles: Removable, stainless-steel with spring-loaded fastening. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

G. Removable Water-Wash Grease Extractor: Stainless steel, tested with hood according to UL 710.

H. Stationary Water-Wash Grease Extractor: Integral, automatically self-cleaning, spraying hot water and detergent over the entire length of exhaust plenum. Fabricate to supply 140 deg F water at 1.25 gpm/ft. of hood length, at 40- to 60-psig inlet pressure.

1. Water Piping: ASTM A 270, Type 304 stainless steel.
2. Fabricate to drain water and detergent to a collection trough having stainless-steel drain fittings.
3. Single, hood-mounting control panel with a solid-state, programmable controller shall control all hoods on Project. Wash cycle shall be factory set to operate for 10 minutes after fans stop.
4. Detergent shall be supplied by an adjustable-flow, 120-V ac injection pump from a reservoir with a minimum capacity of 2.5 gal. (9.5 L).

I. Lighting Fixtures: Surface-mounted, [fluorescent] [incandescent] fixtures and lamps with lenses sealed vaportight. Wiring shall be installed in conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc (753 lx) at 30 inches (762 mm) above finished floor.

1. Light switches shall be mounted [on front panel of hood canopy] [on wall adjacent to hood] [in hood control panel].
2. Lighting Fixtures: Incandescent complying with UL 1598.

J. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for hood controls.

K. Hood Controls: Hood-mounting control cabinet, factory wired to control groups of adjacent hoods, and fabricated of stainless steel.

1. Exhaust Fan: On-off switches shall start and stop the exhaust fan. Interlock exhaust fan with makeup air supply fan to operate simultaneously. Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation. Motor starters shall comply with Section 262913 "Enclosed Controllers."

L. Capacities and Characteristics: Refer to schedules for information

2.4 TYPE II EXHAUST HOOD FABRICATION

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Captive Air
2. Greenheck.
3. Approved equal

C. Fabricate hoods according to NSF 2, "Food Equipment."

D. Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible."

E. Hood Configuration: Exhaust only.

1. Makeup air shall be introduced by a separate unit for the space.

F. Hood Type: Heat and vapor removal.

G. Hood Style: Wall-mounted canopy.

H. Condensate Hood Baffles: Removable, stainless-steel baffles to drain into a hood drain trough, and stainless-steel drain piping.

I. Lighting Fixtures: Surface-mounted, incandescent fixtures and lamps with lenses sealed vaportight. Wiring shall be installed in stainless-steel conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc at 30 inches above finished floor.

1. Light switches shall be mounted on front panel of hood canopy.
2. Lighting Fixtures: Incandescent complying with UL 1598.

J. Capacities and Characteristics: refer to schedules for information.

2.5 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

A. Wet-Chemical Fire-Suppression Systems shall be manufactured by:

1. Ansul Incorporated; Tyco International

2. Kidde Fire Systems
3. Badger Fire Protection
4. Approved Equal.

B. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.

1. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
4. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
5. Furnish electric-operated gas shutoff valve; refer to Section 231123 "Facility Natural-Gas Piping."
6. Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.
7. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.
8. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm and wiring to start fan with fire alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.

B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.

D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

E. Install hoods to operate free from vibration.

F. Install seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."

G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

J. Set initial temperatures and calibrate sensors.

K. Set field-adjustable switches.

3.3 CONNECTIONS

A. Install piping with clearance to allow service and maintenance.

B. Install reduced-pressure backflow preventer on washer-water supply. Backflow preventer is specified in Section 221119 "Domestic Water Piping Specialties."

C. Install washer-water drain piping full size of hood connection to an adjacent floor drain or floor sink.

D. Makeup Water Connection: Comply with applicable requirements in Section 221119 "Domestic Water Piping Specialties" for valves and accessories on piping connections to water-cooled units.

E. Connect ducts according to requirements in Section 233300 "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquid tight joint.

F. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. 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.

D. Tests and Inspections:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
4. Perform hood performance tests required by authorities having jurisdiction.
5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 38 13

SECTION 23 55 33

GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes gas-fired unit heaters.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For gas-fired unit heaters. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Retain option in subparagraph below if thermostat is specified in this Section; delete if thermostats for these units are specified in Section 230923 "HVAC Instrumentation and Controls."
5. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.
    a. Items penetrating roof and the following:
        i. Vent and gas piping rough-ins and connections.

B. Seismic Qualification Certificates: For gas-fired unit heaters, accessories, and components, from manufacturer.

C. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

D. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

E. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.06 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.

B. Fan Belts: One for each belt-driven fan size.

1.07 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings or a comparable product by one of the following:

1. Trane
2. Lennox Industries, Inc.
3. Modine Manufacturing Company.
4. Reznor/Thomas & Betts Corporation.
5. Sterling HVAC Products; Div. of Mestek Technology Inc.

2.02 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Capacities and Characteristics: Refer to schedules for information.

2.03 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

C. Type of Venting: Power vented.

D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
2. Discharge Louvers: Independently adjustable, horizontal blades.

E. Accessories:

1. Four-point suspension kit.
2. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
3. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes and flashing for wall or roof penetration.

F. Heat Exchanger: Aluminized steel.

G. Burner Material: Aluminized steel with stainless-steel inserts.

H. Propeller Unit Fan:

1. Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.

2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

I. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Enclosure Materials: Rolled steel.
3. Motor Bearings: <Insert requirements>.

J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: Two stage.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: Flame rollout switch.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Thermostat: Devices and wiring are specified in Section 230923 "Temperature Instruments."
8. Wall-Mounted Thermostat:
   a. Two stage.
   b. Fan on-off-automatic switch.
   c. 24-V ac.
   d. 50 to 90 deg F operating range.

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.02 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

C. Gas Piping: Comply with Section 231123 "Facility Natural-Gas Piping" Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Section 235123 "Gas Vents."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

1. Verify bearing lubrication.
2. Verify proper motor rotation.
3. Test Reports: Prepare a written report to record the following:
    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 23 55 33

SECTION 23 62 00

PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged, refrigerant compressor and condenser units.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressor and condenser units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
2. Product Data for Credit EA 4: Documentation indicating that compressor and condenser units and refrigerants comply.

C. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

D. Delegated-Design Submittal: For compressor and condenser units 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. 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.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which compressor and condenser units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.
6. Evaporators.

B. Seismic Qualification Certification: For compressor and condenser units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

D. ASME Compliance: Fabricate and label water-cooled compressor and condenser units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete" and Section 033053 "Miscellaneous Cast-In-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate location of piping and electrical rough-ins.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Compressor failure.
   b. Condenser coil leak.
2. Warranty Period: Five years from date of Substantial Completion.
3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
4. Warranty Period (Components Other Than Compressor): Five years from date of Substantial Completion.
5. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS (3.5 TO 17.6 kW)

A. Manufacturers:

1. Carrier Corp.
2. Lennox Industries Inc.
3. Trane Company (The); North American Commercial Group.
4. Mammoth Inc.
5. Or approved equal.

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: Single speed and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
3. Accumulator: Suction tube.

D. Refrigerant: R-22 (Replacement) R-410A (New).

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.

G. Accessories:

1. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
2. Crankcase heater.
3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
4. Low-voltage thermostat and subbase to control compressor and condenser unit and evaporator fan.
5. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
6. Filter-dryer.
7. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
8. Liquid-line solenoid.
9. Low-Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F (minus 18 deg C) with time-delay relay to bypass low-pressure switch.
10. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
11. PE mounting base.
12. Pre-charged and insulated suction and liquid tubing.
13. Sound Hood: Wraps around sound attenuation cover for compressor.
14. Thermostatic expansion valve.
15. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
16. Reversing valve.

H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

I. Capacities and Characteristics:

1. Refer to drawings and schedules

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to ARI 206/110.

B. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."

C. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Comply with requirements for piping in other Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect pre-charged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casing.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow and air temperature rise over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 23 62 00

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SECTION 23 73 13

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Variable-air-volume, single-zone air-handling units.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
   a. Certified fan-performance curves with system operating conditions indicated.
   b. Certified fan-sound power ratings.
   c. Fan construction and accessories.
   d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lennox
2. Carrier
3. Trane
4. Approved equal.

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Factory Finish for Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type II.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
   a. Liner Adhesive: Comply with ASTM C 916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:
   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
3. Locations and Applications:
   a. Fan Section: Inspection and access panels.
   b. Access Section: Doors.
   c. Coil Section: Inspection and access panel.
   d. Damper Section: Inspection and access panels.

D. Condensate Drain Pans:

1. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches (50 mm) deep.
2. Single-wall, stainless-steel sheet.

3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
   a. Minimum Connection Size: NPS ¾".

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.

C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

D. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double.

E. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Mount unit-mounted disconnect switches on [exterior] [interior] of unit.
6. <Insert unique motor characteristics>.

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.

4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Disposable Panel Filters:

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 1 inch (25 mm).

2.6 CAPACITIES AND CHARACTERISTICS: Refer to schedules

2.7 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Refrigerant Coils: Factory tested to 450 psig (3105 kPa) according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 3/4, ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that outdoor- and return-air mixing dampers open and close and maintain minimum outdoor-air setting.
8. Comb coil fins for parallel orientation.
9. Verify that proper thermal-overload protection is installed for electric coils.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust.

B. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13

SECTION 23 74 13

PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Hot-gas reheat.
3. Gas furnace.
4. Economizer outdoor- and return-air damper section.
5. Integral, space temperature controls.
6. Roof curbs.

B. Related Sections include the following:

1. Section 237333 "Indoor, Indirect, Gas-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air with heat exchangers.
2. Section 237339 "Indoor, Direct-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air without heat exchangers.
3. Section 237433 "Dedicated Outdoor-Air Units" for outdoor equipment air conditioning 100 percent outdoor air to replace air exhausted from a building.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VVT: Variable-air volume and temperature.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design RTU supports to comply with wind and seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

D. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.
2. Roof openings
3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Carrier Corp.
2. Daikin Applied
3. YORK International Corporation.

4. AAON
5. Trane Company (The); North American Commercial Group.
6. Lennox Industries Inc.
7. Or approved equal.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.052 inch (1.3 mm) thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch (0.86 mm) thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness:1 inch (25 mm).
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches (50 mm) deep and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, backward inclined, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

C. Relief-Air Fan: Propeller, shaft mounted on permanently lubricated motor.

D. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

E. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Baked phenolic coating.
5. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Baked phenolic coating.

C. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Baked phenolic coating.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.

4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber: Minimum 80 percent arrestance, andMERV 5.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.

E. Safety Controls:

1. Gas Control Valve: Modulating.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.

2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. DDC Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:
   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
   b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
   c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 283111 "Digital, Addressable Fire-Alarm System" and Section 283112 "Zoned (DC Loop) Fire-Alarm System."
   d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F (4 deg C).
   e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
3. Scheduled Operation: Occupied and unoccupied periods on [seven] [365]-day clock with a minimum of [two] [four] programmable periods per day.
4. Unoccupied Period:
   a. Heating Setback: [10 deg F (5.6 deg C)] <Insert temperature>.
   b. Cooling Setback: System off.
   c. Override Operation: [Two] <Insert number> hours.
5. Supply Fan Operation:
   a. Occupied Periods: Run fan continuously.
   b. Unoccupied Periods: Cycle fan to maintain setback temperature.
6. Refrigerant Circuit Operation:
   a. Occupied Periods: Cycle or stage compressors and operate hot-gas bypass to match compressor output to cooling load to maintain discharge temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
   b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
   c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.
7. Hot-Gas Reheat-Coil Operation:
   a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
   b. Unoccupied Periods: Reheat not required.

8. Gas Furnace Operation:
   a. Occupied Periods: Modulate burner to maintain discharge temperature.
   b. Unoccupied Periods: Cycle burner to maintain setback temperature.
9. Economizer Outdoor-Air Damper Operation:
   a. Occupied Periods: Open to maximum 45 percent intake based on CO2 Demand Control Ventilation, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F (15 deg C). Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
   b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
   c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc.
10. Carbon Dioxide Sensor Operation:
    a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
    b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
11. VVT Relays:
    a. Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Section 233600 "Air Terminal Units" and Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet compatible interface for central HVAC control workstation for the following:
   a. Adjusting set points.
   b. Monitoring supply fan start, stop, and operation.
   c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
   d. Monitoring occupied and unoccupied operations.
   e. Monitoring constant and variable motor loads.
   f. Monitoring variable-frequency drive operation.
   g. Monitoring cooling load.
   h. Monitoring economizer cycles.
   i. Monitoring air-distribution static pressure and ventilation air volume.

2.11 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

C. Low-ambient kit using variable-speed condenser fans for operation down to 35 deg F (1.7 deg C).

D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

E. Coil guards of painted, galvanized-steel wire.

F. Hail guards of galvanized steel, painted to match casing.

G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.12 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C 1071, Type I or II.
   b. Thickness: 1 inch
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C 916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
   d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: min. 18”.

D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

E. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs having 2-inch static deflection and vertical and horizontal restraints; with elastomeric waterproof membrane.

2.13 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedules for RTU performance data.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 221123 "Facility Natural-Gas Piping" Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.

2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified with concrete.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.

11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.
29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 74 13

SECTION 23 74 33

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:

    a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
    b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five (5) years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Daikin Applied
2. Carrier Corp.
3. YORK International Corporation.
4. AAON
5. Trane Company (The); North American Commercial Group.
6. Lennox Industries Inc.
7. Or approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

B. Cabinet Thermal Performance:

1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
2. Include effects of metal-to-metal contact and thermal bridges in the calculations.

C. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.

D. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

E. Cabinet Deflection Performance:

1. Walls and roof deflection shall be within 1/200 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
2. Floor deflections shall be within 1/240 of the span considering the worst-case condition caused by the following:

a. Service personnel.
b. Internal components.
c. Design working pressure defined for the walls and roof.

F. 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.

G. Capacities and Characteristics: Refer to drawings and schedule

2.3 CABINET

A. Construction: double wall.

B. Exterior Casing Material: Galvanized steel with paint finish.

C. Interior Casing Material: Galvanized steel.

D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.

F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.

G. Roof: Standing seam or membrane; sloped to drain water.

H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

I. Cabinet Insulation:

1. Type: Injected Foam
2. Thickness: 1 inch
3. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:

1. Shape: Rectangular, with **1** percent slope in at least two planes to direct water toward drain connection.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.

    a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1
    b. Depth: A minimum of 2 inches.

3. Configuration: Single wall.
4. Material: Stainless-steel sheet.
5. Drain Connection:

    a. Located on one end of pan, at lowest point of pan.
    b. Terminated with threaded nipple.
    c. Minimum Connection Size: NPS 1.

6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

L. Roof Curb: Full-perimeter vibration isolation roof curb of sheet metal, minimum 18” tall high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

1. Comply with requirements in "The NRCA Roofing Manual."

2.4 SUPPLY FAN

A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.

1. Fan Wheel Material: Galvanized, Coated steel, mounted on solid-steel shaft.
2. Bearings: Pillow-block bearings rated L_{50} for 200,000 hours and having external grease fittings.

B. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.

C. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Enclosure: Open dripproof.
3. Enclosure Materials: Cast iron.
4. Motor Bearings:

5. Efficiency: Premium efficient.

D. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.

2.5 COOLING COILS

A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

F. A drain pan over flow safety shall shut off the unit and issue a warning before over flow occurs.

2.6 INDIRECT-FIRED GAS FURNACE HEATING

A. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.

B. Each module shall have two stages of heating control.

C. The heat exchanger tubes shall be constructed of stainless steel.

D. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.

E. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

F. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.7 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.8 FILTERS

A. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, viscous-coated, flat-panel type.
3. Thickness: 2 inches
4. Minimum Merv: 8 , according to ASHRAE 52.2.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive

B. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.9 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a [**single-point**]field power connection to unit.

B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Factory-Mounted, Overcurrent-Protection Service: For each motor.

F. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

G. Controls: Factory wire unit-mounted controls where indicated.

H. Lights: Factory wire unit-mounted lights.

I. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

J. Control Relays: Auxiliary and adjustable time-delay relays.

2.10 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Control Wiring: Factory wire connection for controls' power supply.

C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

2.11 ACCESSORIES

A. Service Lights and Switch: Factory installed in each accessible section and on exterior of unit with weatherproof cover. Factory wire lights to a single-point field connection.

B. Duplex Receptacle: Factory mounted on the exterior of the unit, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."

1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

C. Restrained Curb Support: Install restrained vibration isolation roof-curb rails on roof structure according to "The NRCA Roofing Manual."

D. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

F. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

G. Install separate devices furnished by manufacturer and not factory installed.

H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Gas Piping Connections:

1. Comply with requirements in Section 231123 "Facility Natural-Gas Piping."
2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
3. Install AGA-approved flexible connectors.

C. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.

3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Alarms.

5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:

    a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
    b. Cooling coil entering-air, dry- and wet-bulb temperatures.
    c. Condenser coil entering-air dry-bulb temperature.
    d. Condenser coil leaving-air dry-bulb temperature.

7. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.

13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.
25. Inspect outdoor-air dampers for proper stroke.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air flow.
    c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 74 33

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed mounting.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.05 COORDINATION

A. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five (5) years from date of Substantial Completion.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin
2. Mitsubishi
3. Carrier
4. Approved equal.

2.02 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Direct drive, centrifugal fan.

D. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Motors." If different characteristics are required, add paragraphs below to suit Project.

E. Fan Motors: Comply with requirements in Division 23 Section "Motors."

F. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

G. Filters: Permanent, cleanable.

2.03 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Owner, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

C. Compressor Type: Reciprocating / Scroll.

D. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

E. Refrigerant Charge: R-410A.

F. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

G. Fan: Aluminum-propeller type directly connected to motor.

H. Motor: Permanently lubricated, with integral thermal-overload protection.

I. Low Ambient Kit: Shall permit operation down to 0 deg F.

J. Mounting Base: Polyethylene.

2.04 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.

3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating ode, and fan speed.
4. Fan-speed selection, including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install unit level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 6 inch thick, reinforced concrete base; 6 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install roof-mounting compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install seismic restraints.

F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Mechanical Vibration Controls and Seismic Restraints."

G. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings.

H. Install tubing to allow access to unit.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding.

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 Section "Closeout Procedures/ Demonstration and Training."

END OF SECTION 23 81 26

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SECTION 23 82 39

CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. DDC: Direct digital control.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit-Heater Filters: Furnish [one] spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Qmark
2. Markel
3. Approved equal.

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 COIL SECTION INSULATION

A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing to prevent erosion of glass fibers.

1. Thickness: 1/2 inch (13 mm)
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F (0.037 W/m x K at 24 deg C) mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.

2.6 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.7 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

C. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied Period Override: [Two] <Insert number> hours.
3. Unit Supply-Air Fan Operations:
   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain setback room temperature.
4. Heating-Coil Operations:
   a. Occupied Periods: Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and energize electric-resistance coil if room temperature falls below setback temperature.
5. Controller shall have volatile-memory backup.

D. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net compatible for central DDC system for HVAC workstation and include the following functions:
   a. Adjust set points.
   b. Cabinet unit-heater start, stop, and operating status.
   c. Data inquiry, including supply-air and room-air temperature.
   d. Occupied and unoccupied schedules.

E. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.8 CAPACITIES AND CHARACTERISTICS: Refer to Schedules

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly, seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration Controls for HVAC.

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

C. Comply with safety requirements in UL 1995.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 23 82 39

SECTION 23 84 16

MECHANICAL DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged, factory-assembled and -tested, refrigerant-type, mechanical dehumidification units designed for outdoor installation.

1.3 PERFORMANCE REQUIREMENTS

A. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each dehumidification unit indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each dehumidification unit indicated. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For dehumidification units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. 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.

E. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

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.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."

2. Applicable requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

C. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - GENERAL

2.1 SCOPE

A. Split system designed for natatorium environment control including:

1. Dehumidification
2. Unit mounted indirect fired gas heater for space heating
3. Cooling mode with heat rejection to a remote outdoor air-cooled fluid cooler (dry-cooler). No site refrigeration work shall be required.
4. Pool water heating from reclaimed compressor waste heat
5. Unit mounted minimum Exhaust Fan
6. Unit mounted minimum Outdoor Air Connection

2.2 QUALITY AND SAFETY ASSURANCE

A. The unit shall be ETL listed.

B. Unit shall be completely factory assembled, wired, piped, and test run prior to shipping. All controls shall be factory adjusted and preset to the design conditions. A factory test report shall be available upon request.

C. Live remote monitoring of the unit during factory testing shall be available via the Internet.

D. The unit shall have a mechanical vestibule where the electrical panel, compressors, pool water heat exchangers, receivers and most of the refrigeration controls are out of the process air stream.

E. Unit shall have a microprocessor controller with unit mounted refrigerant pressure transducers on each independent compressor circuit, multiple temperature sensors and an Ethernet connection for factory monitoring, adjusting and control via the internet. The refrigerant pressure transducers shall be actively used for unit control. A weekly graph of the space conditions shall be provided to the customer. Demonstration of these capabilities must be carried out at the engineer's office prior to bid day.

F. Internet Start-Up assist: The unit shall have remote factory start-up capability via the Internet.

G. The unit shall have 24-7 remote computer monitoring with automated alarm notifications and system performance alerts.

H. Warranty: The entire system shall have a 24 month limited parts warranty from ship date.

1. The system shall be covered by an additional 1-year labor warranty when it is connected to the factory via live internet monitoring system from date of initial start-up.

2. The compressor(s) shall have a 5 year warranty from ship date.

I. The unit shall have live remote service capability via the internet with the ability for field service technicians to receive service and trouble alerts via email and make adjustments via smart-phone application remote control.

PART 3 - PRODUCTS

3.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Munters.
2. Seresco
3. Pool Pak
4. Innovent
5. Desert Aire
6. Or approved equal.

3.2 GENERAL

A. The natatorium control system shall include:

1. Mechanical process dehumidification
2. Outdoor configuration
3. Split system with remote outdoor air-cooled dry cooler for AC heat rejection.
4. The unit shall have an indirect fired natural gas heater installed downstream of the blower, sized to meet the skin losses and outdoor air heating loads or as specified by the design engineer.
5. Pool water heating type: coaxial
6. Air filtration type: MERV 8 2-inch filters for return and outdoor air.
7. Minimum Outdoor Air connection.
8. Minimum Exhaust Fan.
9. Programmable microprocessor controller with Live, 24-7 remote internet access, monitoring and control.
10. Remote operator panel
11. Unit shall have a service vestibule where the compressor, refrigeration specialties and control valves and all electronics are outside of process air stream.

B. Sequence of Operation

1. Unit shall be designed and sized to maintain the specified conditions. The unit operation shall be as follows:

a. Unit Startup
b. Power is turned on or system is restarted.
c. After a short initial delay to allow sensors to stabilize, the blower starts and operates continuously.
d. Based on unit mounted sensor feedback the unit shall begin/resume operation and will operate based on the sequence described below.

2. Airside Configuration

a. The unit delivers specified supply air continuously to the Natatorium.
b. The minimum exhaust air volume is set to meet the engineer’s schedule.
c. The minimum outdoor air volume is set to meet the engineer’s schedule.

3. Dehumidification Mode

a. Return air relative humidity is above humidity setpoint.
b. Compressor starts using Compressor Start sequence.
c. Initially all compressor hot gas will be diverted to condense at the reheat coil. The supply air temperature is warmer than the return air temperature.

4. Air Conditioning Mode

a. Return air temperature is above room temperature setpoint.
b. Compressor starts if not already operating in dehumidification mode.
c. Unneeded compressor hot gas is diverted to a refrigerant to glycol fluid cooled heat exchanger. Up to 100% of compressor heat is rejected into the glycol fluid which in turn is pumped outdoors to an outdoor air-cooled heat exchanger for 100% heat rejection at summer design ambient conditions.

5. Space Heating Mode

a. Return air temperature is below room temperature setpoint.
b. The Microprocessor space heating output signal (0-10 volt) is sent to the heating coil controller. The signal output will regulate based on the return air temperature.

6. Pool Water Heating Mode

a. Return pool water temperature is below pool water setpoint.
b. If compressor is already operating from a Dehumidification or Air Conditioning demand, the control valves divert the compressor hot gas through the coaxial heat exchanger/pool water heater and the rest of the compressor heat is rejected at either the reheat coil or the AC heat exchanger.
c. If there is no pre-existing demand for the compressor to operate, the microprocessor sends a signal to the auxiliary pool water heater (remote by others) to operate. The compressor will not normally operate solely for a pool water heating demand unless configured to do so at the controller.

7. Freeze Protection

a. Supply air temperature falls below freezestat setpoint or optional freezestat sensor indicates a freezestat condition.
b. All exhaust fans are stopped and all outdoor air dampers are fully closed.
c. Freezestat alarm is tripped. Alarm has to be manually cleared by operator.

C. Cabinet

1. The Cabinet shall be designed for Outdoor installation and shall be 2" double walled with painted inner liner.

2. Cabinet Construction: All cabinet 16, 20, 24 gauge sheet metal shall be galvanized G90 steel or GalvalumeTM alloy, mill applied zinc phosphate primer followed by an exterior grade white silicone modified polyester top coat. The sheet metal is engineered to form a cabinet with maximum strength and rigidity. Panels shall be fastened to the frame with stainless steel hardware. Panels shall be isolated from the steel frame with dielectric gaskets to prevent galvanic corrosion. All seams shall be caulked with silicone inside and out to prevent air and water leakage.

3. Base Rails: The unit base frame shall be formed of 2 layers of 10 gauge galvanized steel. Lifting lugs shall be provided on the base frame for rigging the unit.

4. The cabinet walls shall be 20 gauge pre-painted steel, 2-inch double-wall construction with a fully painted inner metal liner and 2-inch fiberglass insulation.

5. The cabinet floor shall be 20-gauge pre-painted steel, 2-inch double wall engineered with structural bending for maximum rigidity and be mechanically fastened to the base frame of the unit.

6. The cabinet roof shall be 20-gauge pre-painted steel, 2-inch double wall engineered with structural bending for maximum rigidity and be mechanically fastened to the base walls of the unit.

7. The cabinets shall be mechanically assembled with stainless steel 5/32" sealed pop rivets. Where bolts are required bright zinc plated bolts shall be used.

8. Access doors shall be supported on multiples hinges and have multiple compression latches to provide quick access. Doors shall be provided for entrance to all sections housing components requiring routine maintenance. Full height access doors have "hold back" latches to prevent door closure during the performance of service procedures.

9. The unit shall have non-corroding protective mesh screens on all air intake openings.

10. Outdoor Air Intake:

    a. Minimum Outdoor Air connection: motorized damper, filter and time clock

11. Insulation: The unit shall be insulated per the following standards:

    a. All exterior cabinet sections shall be insulated with two (2) inch thick fiberglass inside the double walled cabinet.
    b. Fire resistant rating to conform to NFPA Standard 90A and 90B.
    c. Sound attenuation coefficient shall not be less than 1.02 at a frequency of 1,000 Hz as per ASTM Standard C423.
    d. Thermal conductivity shall not exceed 0.26 Btu/in-h-sq/ft-F at 75 F.

12. Cabinet configuration shall include:

    a. A filter rack with separate access doors shall be provided for the return air and minimum outdoor air streams.
    b. Unit shall be equipped with duct collars to admit the minimum outdoor air as scheduled. The outdoor air intake assembly shall have a built in air filter rack with separate access door, manual air balancing device and motorized 2 position extruded aluminum, Insulated, silicone side-sealed damper operated by 24-hour time clock.
    c. Mechanical vestibule: The unit shall have the compressor, receiver, solenoid valves and the electrical panel in a separate compartment out of the processed air stream. All components shall be serviceable while the unit is in operation without disturbing the airflow.
    d. Electrical panel: The unit shall have a built-in electrical control panel in a separate compartment in order not to disturb the airflow within the dehumidifier during electrical servicing. All electrical components shall be mounted on a 16 gauge galvanized sub-panel.

D. Filters

1. Filters shall be standard sized, replaceable, off-the-shelf filters used throughout including:

    a. Return Air: 2-Inch MERV 8, 30% pleated filters with rust-free non-metallic structure on a slide in rack.
    b. Outside Air: 2-Inch MERV 8, 30% pleated filters with rust-free non-metallic structure

E. Coils

1. Evaporator/dehumidifier coils shall be designed for maximum moisture removal capacity.

2. Coils shall be fully dipped and coated with a polyester/enamel coating for maximum corrosion protection. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance against common acids, salt and gases.

3. Coil shall have galvanized casing and end plates.

4. Aluminum fin and copper tubes mechanically bonded to assure high heat transfer.

    a. Air reheat condenser coils shall be sized for variable heat transfer into the air with a capacity of 100% of the compressors total required heat of rejection.

5. Coils shall be fully dipped and coated with a polyester/enamel coating for maximum corrosion protection. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance against common acids, salt and gases.

6. Coil shall have galvanized casing and end plates.

7. Aluminum fin and copper tube joints mechanically bonded to assure high heat transfer

F. Drain Pans

1. Each evaporator coil shall be provided with a positive draining, compound-sloped, baked powder paint coated aluminum drain pan with fully-welded corners to ensure zero water retention.

G. Blowers and Blower Motors

1. Supply blowers:

    a. The Supply blower shall be impeller plenum fan complete with backward curved, three-dimensional, profiled blades made of high performance composite material. The blower shall be completely corrosion resistant and be maintenance free and is direct drive via a direct current (DC) electronic commuted (EC) motor. The EC-Motor shall have zero slippage design and have continuously variable speed control when connected to the unit’s controller.

    b. The EC motor shall have maintenance-free electronic circuitry, a rotor with permanent magnets, and an integral controller to provide the windings with electrical current so that, the motor rotates continuously and quietly.

c. The fan assembly shall be suitable for a maximum temperature of 60°C.

d. The fan shall be statically and dynamically balanced on precision electronic balancers.

2. Exhaust blowers:

a. The exhaust blower (EF1) sized to maintain the Natatorium's negative pressure requirement during normal operation shall be unit mounted and its operation tied to the unit's occupancy scheduler.

b. The blower shall be impeller plenum fan complete with backward curved, three-dimensional, profiled blades made of high performance composite material. The blower shall be completely corrosion resistant and be maintenance free a direct drive via a direct current (DC) electronic commuted (EC) motor.

c. The EC-Motor shall have zero slippage design and have continuously variable speed control when connected to the unit's controller.

d. The fan assembly shall be balanced in Class G 6.3 acc DIN ISO 1940, dynamic on two levels.

e. The fan assembly shall be suitable for ambient temperatures of -40°C to max. +70°C.

f. Thermal contacts installed in the windings compliant with THCL 155.

g. Drive motor in external rotor principle, sealed in protection class IP54 with moisture protection impregnation of the windings, topical protection.

h. High corrosion resistance design with high quality and reliability.

i. The exhaust fan shall be controlled from an end switch on the power open of the exhaust air damper. The exhaust dampers shall be protected by louvers to divert rain from the face of the dampers.

H. Dampers

1. Internal dampers shall be parallel blade and made from extruded anodized Aluminum with neoprene double seal tips to minimize leakage. Damper blades shall be mounted on steel rods which rotate on nylon bushings. All damper hardware shall be corrosion resistant.

a. Unit shall be provided with a power open and spring return outside air and exhaust air dampers. Dampers adjust between 0% to 100% open position.

b. Outdoor air and exhaust air dampers shall be opposed blade, power open and spring return. Dampers blades shall be 3/4? insulated type made from extruded anodized Aluminum with neoprene double seal tips to minimize leakage. Damper leakage shall be less than 1% of maximum flow at 4-inch W.C. differential. Damper blades shall be mounted on steel rods which rotate on nylon bushings. All damper hardware shall be corrosion resistant.

I. Pool Water Heater

1. Coaxial type with corrosion resistant cupro-nickel water circuit tubing.

2. Coaxial type with corrosion resistant cupro-nickel water circuit tubing.
3. Self-purging and self-draining counter flow design.
4. Water circuit piping shall be transparent braided hose, for visual water flow confirmation.
5. Terminating connections are PVC schedule 40 NPT fittings located at the cabinet wall for easy connection.
6. Maximum loop operating pressure: 60 psig

J. Compressors

1. Type: Scroll type, suction gas cooled, suitable for refrigerant R-410A
2. Internal protection: Equipped with internal solid-state thermal protection sensor,
3. Access: Service access valves for convenient servicing.
4. The compressors shall be mounted on rubber in shear isolators to prevent transmission of any noise and vibration to the space below.
5. Removable crankcase heater for liquid migration protection.
6. Compressors shall be located outside the conditioned air stream in the unit's service vestibule.
7. Compressors shall have a 3-year warranty extension for a total of 5 years coverage.
8. Compressor manufacturer must have a wholesale outlet for replacement parts in the nearest major city.

K. Refrigeration Circuit

1. The unit shall consist of one factory sealed refrigeration circuit for humidity and/or air conditioning control. No site refrigeration work shall be required.
2. Refrigeration circuit shall have pressure transducers monitoring the refrigerant high and low pressures. The refrigeration circuit shall be accessible for diagnostics, adjustment and servicing without the need of service manifold gauges.
3. Shall have solenoid control valves, check valves, a liquid line filter drier, liquid and moisture indicator, thermostatic expansion valve and pump down solenoid valve.
4. Unit shall have an externally adjustable balanced port design mechanical thermostatic expansion valve. The valve shall have a removable power head.
5. Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schrader type valves. Refrigeration service valves shall be located outside of the airstream.
6. Receiver shall have two refrigerant level (maximum and minimum) indicating sight glasses.
7. Suction line shall be fully insulated with ½ inch closed cell insulation.

L. Control Panel

1. Electrical contractor shall be responsible for external power wiring and disconnect switch fusing. Power block terminals shall be provided.
2. Factory-installed non-fused disconnect
3. Shall be mounted inside the service vestibule outside of the process air stream.
4. Blower motors shall be protected with thermal trip overloads.
5. Unit shall have a voltage monitor with phase protection.
6. Available dry contacts shall include:
   a. Alarm
   b. Blower interlock
   c. Stage 1 & 2 heating
   d. Outdoor air damper control
   e. Remote exhaust fan #1
   f. Remote exhaust fan #2

g. Outdoor-air cooled equipment
h. System on
i. Auxiliary pool heater 1
j. Heat recovery

7. Terminals shall be provided for 24 volt power to the outdoor air cooled condenser fan contactor.
8. All wiring shall be installed in accordance with UL or CSA safety electrical code regulations and shall be in accordance with NFPA. All components used shall be UL or CSA listed.
9. Color-coding and wire numbering shall be provided for easy troubleshooting. All wires shall be in a wire duct. Wiring diagrams located near electrical panels on unit.
10. Compressors shall have a time delay start to prevent short cycling.
11. Pressure transducers for refrigerant high pressure and suction pressure shall be provided.
12. Airflow switch and dry contact for alarm shall be provided.

M. Microprocessor Control

1. A microprocessor controller with the following characteristics will be provided:
2. All set points and adjustments are preprogrammed at the factory during quality control and test operation.
3. The microprocessor program has an updatable FLASH memory.
4. The Flash memory will be updatable via an internet connection.
5. A minimum: 11 Analog inputs, 4 Analog outputs, 24 Digital inputs and 16 Digital outputs.
6. Four serial interface ports including both RS232 and RS485 types.
7. An Ethernet port with RJ-45 connector and LED activity indicator.
8. A real time clock to time stamp unit operation log with programmable 7-day occupied/unoccupied scheduling capabilities.
9. Two manual demand forced modes to allow user a manual bypass of the microprocessor in the event of controller failure.
10. Keypad and display panel shall have a backlit graphic liquid crystal display.
11. Unit shall have pressure transducers monitoring the refrigerant high and low pressures. The refrigeration circuit shall be accessible for diagnostics, adjustment and servicing without the need of service manifold gauges.
12. The following status LEDs shall be on the controller:
    a. Alarm - indicates there has been a failure requiring service.
    b. Dehumidification - indicates that the system is dehumidifying the space.
    c. Cooling - indicates that the air-conditioning mode.
    d. Pool Heating - indicates that the system is heating the pool water with recycled energy.
    e. Space Heat - indicates that the space heating is operating.
    f. Maintenance - indicates whether or not maintenance is required.
    g. Manual - indicates that the system has been set to manual operation.
13. The following set points shall be accessible and adjustable from the display panel:
    a. Space temperature
    b. Space relative humidity
    c. Pool water temperature
14. The following sensors shall be unit-mounted and monitored at the display panel. All information from these items shall be actively used in the control and operation strategies for the unit:
    a. Refrigerant high pressure
    b. Refrigerant low pressure
    c. Return air temperature
    d. Supply air temperature
    e. Return air relative humidity
    f. Entering pool water temperature

g. Leaving pool water temperature
h. Evaporator leaving air temperature
i. Suction temperature
j. Discharge temperature

15. System Fault: Shall indicate via text message to the display what systems require attention or servicing. Built-in monitoring and diagnostics shall allow the user to view the following:
    a. Power Failure
    b. Dirty air filter
    c. Refrigerant high and low pressure
    d. System off
    e. Anti-short cycle delay

N. WebSentry Conditional One Year Extended Labor Warranty (Provided at no additional charge)

1. The initial 90-day warranty shall be extended for a total of 12 months from initial start-up and prior to the completion of the 24th month from date of shipment, whichever comes first and subject to prior written approval from the factory. The provided equipment must be connected and communicating to Seresco's WebSentry online control and monitoring service from start-up for the entire term of the warranty extension. Seresco Technologies Inc. will provide and/or reimburse the required labor, materials, and shipping and handling costs incurred in the replacement or repair of a factory installed defective part. The labor required to replace the defective part is under warranty. Travel time, diagnostic time, per diems, truck charges, etc. are not covered under this warranty.

2. The dehumidifier shall have a Cat 5 internet connection for continuous communication with Seresco’s servers.

3. Customer shall have 24/7/365 remote access to the dehumidifier through the Seresco web at no additional charge for the life of the unit.

4. Once connected to the Seresco Servers the customer and the customer’s service provider will have full remote access to the system microprocessor.

5. Once connected to the Seresco servers the factory monitoring will send an email to everyone on the notification list whenever an alarm occurs.

O. Air Heating

1. Unit-mounted indirect fired gas heater shall be sized to meet the scheduled heating capacity and have the following characteristics:

    a. Modulating control.
    b. The heater shall be spark ignition natural gas indirect fired type with capacity as shown in this submittal and is installed 'blow through' or downstream from the blower. The heat exchanger tubes are constructed of formed and welded series 409 stainless steel, 16 gauge suitable for installation downstream of the cooling coil and satisfactory for air inlet temperatures below 40 F. The burner is the power firing type and incorporates a primary combustion air blower and spark ignition transformer.
    c. Standard controls shall include a modulating gas valve, intermittent spark ignition; overheat control, rollout flame supervision, combustion air flow proving switch, positive burner safety switch, pilot cock, main gas cock with 100% shut off, adjustable main and pilot pressure regulators.

d. The natural gas heater section shall be an ETL recognized component. The gas train shall be complete with all controls factory mounted to comply with requirements of ETL. The gas train is complete with a modulating main gas valve and is ready for connection to a natural gas supply with pressure between 7 in and 14 in WC.
e. The complete unit shall be test fired and preliminary adjustments made prior to leaving the factory.

P. Air Conditioning

1. Air-cooled air conditioning via fluid cooler

a. Unit shall be equipped with air conditioning mode where excess compressor heat is rejected to an outdoor air-cooled heat exchanger (aka Dry Cooler) via a single pipe set glycol fluid loop. No site refrigeration work shall be required. The unit mounted fluid cooled condenser and remote outdoor air-cooled heat exchanger shall both be capable of rejecting 100% of the compressor heat rejection with an air on temperature at summer design conditions.
b. Unit shall be provided with a dry contact rated for 24VAC/5A to operate the remote outdoor fluid cooler control.
c. Refrigeration circuit shall include refrigerant valves, receiver with pressure relief valve set at 550 psig, pressure control valve and pressure differential valve, and two manual shutoff valves to isolate the outdoor fluid cooler.
d. Coils shall be tested at 425 PSIG and mounted vertically for complete surface utilization. Coils shall be counter flow and have adequate capacity to dissipate the total heat rejection of the system at design conditions. Dry-cooler shall have guards to protect the coils from vandalism and weather related damage.
e. The fan shall be a direct driven axial fan made with a dual speed external rotor motor with innovative bionic blades in die-cast aluminum moulds.
    i. The fan assembly shall be balanced in Class G 6.3 acc DIN ISO 1940, dynamic on two levels.
    ii. The fan assembly shall be suitable for ambient temperatures of -40°C to max. +70°C.
    iii. Thermal contacts installed in the windings compliant with THCL 155.
    iv. Drive motor in external rotor principle, sealed in protection class IP54 with moisture protection impregnation of the windings, topical protection.
    v. High corrosion resistance design with high quality and reliability.

Q. Factory Performance Testing

1. The unit shall be thoroughly tested under factory test conditions. A copy of the test report shall be available to the engineer upon request.
2. Microprocessor controls shall be factory adjusted and preset to the design conditions during testing.
3. The unit shall be accessible for real-time monitoring while in the QC test chamber upon request.

PART 4 - EXECUTION

4.1 PRODUCT DELIVERY, ACCEPTANCE, STORAGE AND HANDLING

A. Perform a thorough physical inspection of the unit upon delivery from the shipment carrier.

B. Identify and report any physical damage immediately to manufacturer.

C. If unit is to be stored prior to installation store in a clean, dry place. Protect from weather, dirt, fumes, water, construction, and physical damage.

D. Handle unit carefully during installation to prevent damage, breaking, denting and scoring.

E. Damaged units or damaged components shall not be installed. Contact manufacturer for RMA instructions.

F. Comply with manufacturer's rigging and installation instructions for unloading the unit and moving it to the final location.

G. Connections

1. Where installing piping adjacent to units, allow space for service and maintenance.
2. Duct connections: Drawings indicate the general arrangements of the ducts. Connect units to ducts with flexible duct connectors. Comply with requirements for flexible duct connectors.
3. Electrical connections: Comply with requirements for power wiring, switches and motor controls in electrical sections.

H. Installation

1. The agency responsible for start-up should work in accordance with the specifications and in accordance with the Seresco's instructions and only by workers experienced in this type of work.

I. Start Up

1. Detailed instructions for startup as provided by the manufacturer must be followed.
2. Installing contractor must contact the manufacturer prior to start up to confirm start up procedures.
3. Remote internet access and control must be initiated and confirmed by the factory prior to start up for extended labor warranty to be in effect.

4.2 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory installed wood nailer; complying with NRCA standards.

C. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I or II.
2. Thickness: 1 inch.
3. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
4. Liner Adhesive: Comply with ASTM C 916, Type I.
5. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

6. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.

D. Curb Height: 18 inches.

F. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs having 2-inch static deflection and vertical and horizontal restraints; with elastomeric waterproof membrane.

4.3 CAPACITIES AND CHARACTERISTICS

A. Refer to schedule for information.

4.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.

B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

PART 5 - EXECUTION

5.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [hot-water] [steam] [refrigerant] piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

5.2 INSTALLATION

A. Equipment Mounting

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

5.3 CONNECTIONS

A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.

B. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.

C. Connect condensate drain pans using minimum NPS 1-1/4 (DN 32) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanout at changes in direction.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

E. Duct installation requirements are specified in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts." Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

F. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure and insulate the space between roof and bottom of dehumidification unit.

5.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Dehumidification unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

5.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform the following final checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connection to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Check lubrication of bearings, pulleys, belts, and other moving parts.
6. Set outside- and return-air mixing dampers to minimum outside-air setting.
7. Install clean filters.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for dehumidification units include the following:

D. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.

E. Measure and record motor's electrical values for voltage and amperage.

F. Manually operate dampers from fully closed to fully open position and record fan performance.

G. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing of dehumidification unit.

H. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

5.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust initial temperature and humidity set points.

5.7 CLEANING

A. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.

B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

5.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

END OF SECTION 23 84 16

SPECIFICATIONS GROUP

Facility Services Subgroup

DIVISION 26 - ELECTRICAL

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SECTION 26 05 00

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. Applicable provisions of the Information for Bidders, General and Special Clauses, General Requirements, govern the work of this section.

1.2 WORK INCLUDED

A. The work under this Division and applicable sections of Division 13000 shall consist of all labor, materials, equipment and services necessary and required to complete all electrical as shown on the Drawings, as described in the specifications, or as inferable from the Drawings and Specifications. Where the words provide or install are used singularly or in combination, it shall mean to furnish and install complete for fully functioning and operational systems. The work shall include but not necessarily be limited to the following:

1. Disconnection and removal of existing underground service cables.

   Installation of underground service cables.
2. Tie-ins to existing 15 KV manhole system. Manholes, hand holes.
3. 480 and 208 volt switchgear.
4. Pad mounted transformers.
5. Lighting and power panelboards and main distribution fuse panelboards, step down transformers, in accordance with drawings, all as indicated on the drawings.
6. Building mains and feeders in accordance with the drawing.
7. Conduit, wiring, outlet boxes, switches, convenience receptacles, etc. for lighting, branches, and relays.
8. Motor disconnect switches as required by Code as shown.
9. Setting controllers furnished by other trades.
10. Lighting fixtures and lamps.

11. Standby Generator for construction.

12. Temporary light and power.

13. Setting of all sleeves, hanger supports and the like.

14. Trenching, excavation and backfill, ductbanks.

15. Cutting and patching for installation of electric work.

16. Testing, adjustments and instructions.

17. Fire alarm.

18. Provide shop drawings for all work.

1.3 WORK NOT INCLUDED

A. The following related items will be covered in other sections of these specifications:

1. Furnishing motors and controllers. (Only controllers shipped in manufactured control panels).
2. HVAC equipment.

1.4 CODES AND STANDARDS

A. All materials furnished and all work installed shall comply, where applicable, with the requirements of the current New York State Building Code, Local Codes and the 2017 National Electrical Code. Whenever reference is made of “National Electrical Code” or “NEC,” it shall mean the 2017 National Electrical Code.

B. Material and work shall comply with other Codes and Standards as may be specified or referenced.

C. Where applicable or specified herein, all material and devices furnished shall meet requirements of Underwriters’ laboratories Inc., shall be U.L. listed and where further applicable, shall bear the U.L. listing mark.

1.5 POWER SHUTDOWN

A. The Contractor may be permitted power shutdowns during normal working hours of 8 a.m. to 3 p.m. Tuesday through Thursday only. Arrange for connections to existing systems as directed by the Engineer, Owner and Utility Company. See Construction Phasing Schedule.

B. The Contractor will schedule and coordinate shutdowns a minimum of two weeks in advance with the Engineer and Owner. Provide at least three (3) days of generator fuel at any time. Pay for all diesel fuel for all shutdowns.

C. The Contractor shall include the cost of performing work during other than normal work hours at overtime or premium wage rates in the bid price. The Contractor will not receive any separate or additional payment for work during other than normal working hours above lump sum bid work included under this Contract.

1.6 FINAL TEST AND INSPECTION

A. The Contractor shall be required to demonstrate to the satisfaction of the Engineer that all the electrical systems, equipment and devices operate as specified.

B. The Contractor shall test the fire systems for proper operation to the satisfaction of the Engineer.

C. All existing systems shall first be tested by owner to insure total system functioning. The contractor shall adapt, connect to, or modify systems as required.

D. Provide fire underwriters certificate of inspection.

1.7 TEMPORARY ELECTRIC LIGHT AND POWER AND GENERATOR

A. The Electrical Contractor shall be responsible for furnishing, installing, maintaining, and upon completion removing, a system of temporary light and power for the use of all construction trades and contracts. If the electrical contractor requires the de-energizing of the utility electric service prior to the power system being installed, then he shall provide a generator sized to accommodate the facility's full load including pumps. Installation of cable, overcurrent devices shall be included in the electrical contractor's bid. This shall include all overtime required to complete work between Tuesday and Thursday.

1.8 CUTTING AND PATCHING

A. The Contractor shall provide all necessary cutting of the walls, floors, ceilings, etc. for installation of conduit, outlet boxes, etc. Cutting shall be kept to a minimum, all areas shall be spray painted for approval prior to any cutting.

B. All finished patching and painting to be by this Contractor. The Electrical Contractor shall completely fill all openings left by the removal of conduit, equipment, etc., with regard to

floor openings, plywood shall be attached to the underside of the slab to facilitate the filling of the opening completely.

1.9 FIREPROOFING

A. All openings through fire proof barriers shall be fully resealed to maintain the fire rating with 3M CP25WB caulking or approved equal.

B. Fire rated barrier and non-flammable supports for floor openings to be KBS Sealbags or equal.

1.10 HEAT SCAN

A. Upon completion of all work under the contract, the Contractor shall perform a heat scan survey of all his work.

B. Scan shall be performed while the facility is under full operation, and equipment at full load.

C. Equipment shall be capable of taking pictures of all areas, especially problem locations.

D. Results shall be neatly assembled and labeled in three (3) binders for the Owner after the Engineer's approval.

1.11 PERFORMANCE REQUIREMENTS

A. The electrical contractor shall verify that all terminations on contract equipment is proper. Testing for phase rotation, continuity and full operation of the equipment shall be performed.

B. The electrical contractor shall render full assistance to all trades for control wiring sequence and unit operation testing.

1.12 ROOF PENETRATIONS

A. No conduit penetrations shall be made through roofs without prior permission of the Owner.

B. Any penetrations allowed will be performed using pitch pockets as approved by the Owner.

1.13 WALL PENTRATIONS

A. All wall penetrations for conduit shall be performed using pre-manufactured wall sleeves as manufactured by Link Seal, OZ Gedney or equal.

1.14 TORQUE REQUIREMENTS

A. All equipment and cable connections shall be tightened to the torque values determined by the manufacturer.

B. Assemble all information after the work is complete in a binder for the owner.

1.15 WORKMANSHIP

A. The Contractor shall perform all operations necessary for the proper installation and operation of all systems.

B. All work performed shall be first class work in every respect. The work shall be performed by mechanics skilled in their respective trades, who shall at all times be under the supervision of competent persons.

C. Work that is slipshod, poorly laid out, not perfectly aligned, or that is not consistent with the requirements generally accepted in the trade for “first class work” will not be acceptable.

D. In addition to the materials specified elsewhere, all other miscellaneous items be necessary for the completion of the work shall be furnished and installed by the Contractor to the extent that all system be complete and operative.

E. Electrical Contractor shall submit references for the foreman to run the project. Electrical Foreman shall have a minimum of five (5) years experience as a working foreman.

1.16 REGULATIONS AND CERTIFCATES

A. All work required by the Drawings and Specifications shall be installed to comply with all applicable building laws, regulations and ordinances of the State of New York, and local laws and regulations as may apply, except where these requirements are exceeded by the Drawings and Specifications in quality or quantity.

B. Any and all changes in the arrangement of the work, either before or after installation, to suit conditions in the building or the work of other trades, and any and all changes required by agencies having jurisdiction shall be made without extra charge, unless the charges are in consequence of changes made by the Owner.

1.17 OPENINGS

A. The admittance into the building of all equipment and materials furnished under this Contract shall be through finished openings. The Contractor shall refer to the Owner for specific requirements relative to the use of building freight elevator if exists and other existing facilities.

1.18 TRENCHING, EXCAVATION, BACKFILL & CONCRETE

A. Contractor shall perform the required trench, excavation, backfill and concrete as indicated on the Drawings and as specified herein. Concrete to be 4000 psi, dyed red, unless otherwise noted.

B. Rock Excavation

1. If rock is encountered, Contractor shall be paid for rock excavation in the following manner:

"Rock Excavation" shall mean the excavation and removal of solid ledge rock which, in the opinion of the Engineer, requires for its removal any or several of the following excavation methods: drilling, wedging, sledging, barring or breaking up with power operated tool. "Rock Excavation" shall also mean the excavation and removal of rock fragments, boulder, masses of masonary, or pieces of concrete (except from existing pavements) regardless of the method employed, provided that the particular piece of material in question exceeds in volume thirteen (13) cubic feet.

The removal of so called "hardpan" frozen earth, hard clay, or other similar material will not be considered "Rock Excavation" even though the material in question cannot be removed by backhoe of "Dipper Stick" without first loosening by blasting or the use of drills, spades or other equipment. Existing road pavements, curbs, gutters and sidewalks shall not be measured as rock. Soft or disintegrated ledge rock which can be removed by heavy excavating equipment (1 CY or over), or rock which falls into the excavation will not be considered "Rock" for payment measurement.

Payment for rock excavation will be made under Lump Sum Proposal/Separate Item on Proposal Page.

Rock payment shall be computed between the following pay lines:

a. Vertical – Top of the rock and bottom of the trench.
b. Horizontal – Width of duct plus 6" clearance from each side or as directed by the Engineer.

1.19 EXPEDITING THE WORK

A. The Contractor shall take all measurements at the job, verify all figured dimensions indicated on the construction drawings, familiarize himself to assure complete knowledge of code requirements and coordinate the work with other trades so as to cause no delay in the work and to eliminate wherever possible future cutting and patching. Any discrepancies or interference shall be reported immediately to the Owner.

1.20 PROTECTION OF THE WORK

A. The Contractor shall provide temporary covering and do all work required to protect work, materials, machinery and equipment from all damage from moisture.

B. After the work is completed, the Contractor shall clean all equipment and piping.

1.21 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish to the Owner one set for initial review and four sets of final written operating, maintenance and lubrication instructions for all installed systems and equipment. Instructions shall include copies of all designated approved shop drawings, manufacturer's descriptive data, control diagrams, wiring diagrams, performance test data, test and balance reports and installation and operating instructions as specified.

B. Operation and Maintenance Submittal Instructions

1. Organize all instructions as follows:
    a. All instructions shall be submitted in electronic format on CD-ROM in the formats described below.
    b. Information shall be organized and saved in separate data files, clearly named.
    c. CD-ROMs submitted shall be clearly labeled, and shall be submitted with a table of contents referencing the specification section of the files contained on them.
    d. Text shall be submitted in Rich Text Format (RFT), or Microsoft Word (doc).
    e. All graphics shall be submitted in Joint Photographics Expert Group (jpeg or jpg) format.
    f. Text shall include written instruction on operating and maintaining the equipment, and at minimum shall include:
        1) Startup instructions
        2) Standard operation instructions
        3) Any emergency or non-standard operating instruction
        4) Design criteria for the equipment, in the table format.

Information shall include standard size information, such as length, width, or diameter, and capacity information such as flow and head that is not included in the nameplate table.

5) A description of the controls provided with the equipment.
6) Troubleshooting in the table format as follows:

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION

7) Nameplate data for the equipment in table format. Nameplate information shall include data for the overall assembly and any major components such as motors, gear reducers, etc.
8) Manufacturer and local vendor information, including address, phone numbers, email addresses, and web sites.
9) Information needed for ordering new parts.
10) Preventive maintenance and lubrication instructions and schedule including recommended lubricants, application points, and a list of special tools required for operation and maintenance.
11) List of spare parts supplied with the equipment, identified by manufacturer's part number.
12) Assembly and disassembly instruction for each preventative or corrective maintenance task.

g. Graphics shall be provided in high resolution (75 dpi or greater) with a maximum width of 820 pixels, and shall include, at minimum:
1) Complete electrical and control schematics with labeled terminations
2) Parts diagrams with parts clearly identified with manufacturer's part numbers
3) Diagrams required for maintenance including lubrication locations, pump packing arrangements, etc.
4) Performance diagrams, such as pump curves, blower curves, etc.

C. The above instructions, charts, etc. shall be submitted to the Engineer as a rough draft and after the required corrections are made, six (6) sets in looseleaf, hardback binders, CDs, suitable indexed and identified, shall be furnished to the Owner.

D. The Owner's designated operating personnel shall be instructed in the proper operation and maintenance of the equipment as well as the operation and maintenance of the controls for the various systems by the vendor's representative. Informal or unwitnessed instructions, or instructions to non-designated personnel will not be acceptable. In addition to the instruction periods specified elsewhere, the Contractor shall

furnish instruction for a minimum of two (2) working day straight time not necessarily consecutive. Prior arrangements for instruction periods shall be made with the Owner.

E. Final payment will not be granted until all manuals and training have been provided to the Owner/Owner's representative.

1.22 RECORD DRAWINGS

A. The Contractor shall maintain an accurate record set of reproducible as-built drawings of any deviations in work as actually installed from the work as indicated on the design drawings. The Contractor shall utilize the contract design drawings for marking up any deviations to the drawings. The record shall be kept current and available at the site for inspection.

B. As-built drawings shall be updated at the site as work progresses.

C. Final payment will not be granted until all final as-built drawings are delivered to the Owner/Owner's Representative.

D. Contractor shall furnish as-built drawings to Engineer at 30%, 60%, and 100% of project completion. As-builts are to be submitted in AutoCAD computer format. Submit three sets of discs and three sets of blueprints.

1.23 GUARANTEE

A. The Contractor shall guarantee clean power throughout the new systems.

B. The Contractor shall guarantee that the capacity of all new equipment installed meets Specification requirements.

C. The Contractor shall guarantee that all new systems will operate without excessive noise and vibration.

D. The Contractor shall obtain from the various manufacturers or vendors standard guarantees or warranties for their particular equipment or components for a period of at least one year, and deliver them to the Owner.

1.24 EQUIPMENT GROUNDING

A. All equipment, panels and devices (except motors) which require electrical connections shall be furnished with a factory-welded (prior to finish painting) ground lug in a concealed and accessible location.

1.25 FINAL INSPECTION

A. The Contractor shall conduct a final inspection of all work installed under each Section of the Specification after the installation have been completed; the testing hereinafter specified has been performed; and test reports have been submitted.

B. During the conduct of the final inspection, the Contractor shall have present a representative of the various manufacturers and a representative of the manufacturers of other pertinent equipment as direct by the Owner.

C. The Contractor shall include in his bid a testing period of two (2) working days wherein all aspects of the electrical systems specified herein will be tested in accordance with detailed test procedures which will be issued by the Owner at a later date. The Contractor shall provide sufficient technical personnel and instruments to perform the tests as directed by the Owner. Personnel for each working day shall include one mechanic, one helper, manufacturer's representative as required, plus GC and HVAC supervisory personnel. The testing period specified herein is in addition to all other testing or instruction periods included in the specifications.

D. The Contractor shall demonstrate, to the satisfaction of the Owner, that the systems installed meet Specification requirements and that the capacities and performances of the equipment meets schedule requirements. The contractor shall make all changes, modifications and adjustments to the installed systems, as directed by the Owner, to meet Specifications requirements, at no additional cost to the Owner.

1.26 ALTERATION AND REMOVAL OF EXISTING WORK

A. The Contractor shall refer to the Contract Documents, for specific requirements relative to the existing facilities and the Sequence of work.

B. All existing systems shall be maintained in operation during the construction period as directed by the Owner. Existing systems shall not be shut down nor shall connections be made thereto without prior approval of the Owner.

C. The Contractor shall relocate all existing conduit hangers and supports, as required to accommodate the new installation at no additional costs to the Owner. This includes all work in spaces where new work is specified under this Contract.

D. Unless otherwise specified or indicated on the Drawings, all equipment, piping, appurtenances, etc. are indicated to be removed from the site when directed by the Owner.

1.27 CONSTRUCTION PHASING SCHEDULE

A. Refer to drawings for phasing schedule.

1.28 SHOP DRAWINGS

A. The Contractor shall submit copies of manufacturer's shop drawings and descriptive literature together with the manufacturer's installation, operating and maintenance instructions, for all equipment to be incorporated in the work including all required wiring diagrams and shall obtain approval before proceeding with the installation.

B. The Contractor shall submit copies of shop drawings at ¼ inch scale or larger showing all conduit mains, including connections to equipment, and all equipment layouts and shall obtain approval before proceeding with the work. Shop drawings shall be accurately dimensioned so that conduit clears all structural members and other work incorporated in the project. The Contractor shall take all shop drawing measurements at the building.

C. The Contractor shall submit the following shop drawings, manufacturer's brochures, manufacturer's installation and operating instructions, etc. for approval before proceeding with the work:

1. Manholes, hand holes
2. Oil filled transformers
3. Wire
4. Raceways
5. Fire Alarm System
6. Wiring Devices
7. Lighting Fixtures
8. Disconnects
9. Mechanical sleeve seals
10. Electrical Identification materials
11. Panelboards
12. 480 and 208 Volt Switchboards
13. Surge suppressors

D. Acceptance of shop drawings does not absolve the Contractor to provide specified materials and function in the intended manner.

1.29 SHOP DRAWING SUBMISSION

A. All shop drawings submitted shall be in multiple sets (minimum 8), and identified by transmittal.

B. The transmittal shall have all appropriate information including, project name, date, specification section, submission number, and item description. It is recommended that the attached transmittal form be used to expedient turn over.

C. If this format is not followed, the Engineer reserves the right to reject any submission.

D. Facsimiles will not be accepted for shop drawings.

1.30 EQUIPMENT PRE-PURCHASED BY THE OWNER

A. In order to permit an accelerated construction completion schedule, the following items of equipment have been pre-purchased by the Owner:

1. _____, automatic transfer switch in outdoor enclosures and all ancillary equipment.
2. Plant Switchgear Building Generator in outdoor enclosure, 3-source automatic transfer scheme and switchgear in NEMA I enclosures and all ancillary equipment.

B. The above mentioned items are being furnished in accordance with purchase specifications previously issued by Owner. The Purchase Specifications are included hereinafter.

C. The Contractor shall assume complete responsibility for accepting delivery of the above mentioned items of equipment at the loading dock, and for inspection, sorting, rigging into place, and making a complete operating installation of the equipment.

D. The Contractor shall notify the Owner within 24 hours of any damage in shipment. Any and all damage to this equipment after delivery to the job site shall be repaired at the Contractor's expense to the satisfaction of the Owner.

END OF SECTION 26 05 00

SHOP DRAWING TRANSMITTAL

PROJECT: _____

DATE: _____

LSE PROJECT NO:_____

LSE PROJECT MANAGER:_____

Item Description/ Manufacturer	Specification Section No.	Submission No.	Disposition
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

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SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

1 GENERAL

1.1 WORK INCLUDED

A. Medium voltage cable.

B. Cable terminations.

1.2 REFERENCES

A. ANSI/IEEE C2 - National Electrical Safety Code.

B. ANSI/NFPA 70 - National Electrical Code.

C. IEEE 48 - Test Procedures and Requirements for High Voltage Alternating Current Cable Terminations.

D. NEMA WC3 - Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

E. NEMA WC5 - Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

F. NEMA WC8 - Ethylene Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

G. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

1.3 PURPOSE AND INTENT

A. This specification covers the construction and testing of 5KV solid dielectric ethylene propylene insulated distribution cables. These cables utilizing a copper tape shield and a black heavy duty jacket shall be used in conduits and in transformers vaults for primary wiring on 5KV systems.

(Engineer to verify compatibility with existing cables as necessary).

1.4 ABBREVIATIONS

A. AEIC - Association of Edison Illuminating Companies.
B. ICEA - Insulated Cable Engineering Association.

C. NEMA - National Electrical Manufacturers Association.

D. ASTM - American Society of Testing Manufacturers.

E. EPR - Ethylene - Propylene Rubber.

F. HTK - High Temperature Kerite.

G. UL - Underwriters Laboratories.

1.5 SHOP DRAWINGS

Shop drawings shall be submitted and approved prior to ordering cables. The following shall be the minimum submitted for approval.

A. Complete manufacturer's construction details and specifications for the cables, including physical and electrical characteristics of insulation, shields and jackets.

B. Overall dimension and ampacity of cable.

C. Splicing and termination data, including the following:
1. Written statement from cable manufacturer that splices and terminations submitted are acceptable.
2. Written statement from splicing/termination manufacturer that splices and terminations submitted are suitable for the proposed application.
3. Details of cable preparation.
4. Method of connecting conductors.
5. List of Materials
6. Method of applying materials (including quantities).
7. Precautionary measures.
8. Drawings showing method of splicing, complete with dimensions.

D. Testing certificates as required in Section 1.6.

E. Written statement from the cable manufacturer consenting to the terms of the warranty, Section 1.12.

1.6 QUALIFICATION TESTING

A. Qualification tests shall be performed by the manufacturer initially on each design of cable and whenever any change occurs in the insulation system or in any other cable component. These tests shall be performed in accordance with AEIC No. CS6 prior to shipment, as applicable.

B. B.1. The completed cable, while on the shipping reel, shall be tested at room temperature at 48KV DC and 24KV AC for five minutes. The insulation resistance shall also be measured and the insulation resistance constant shall not be less than 21,000 megohms/1000 ft. corrected to 60 degrees F.

OR

B.2. The completed Ethylene Propylene Rubber (EPR) cable shall be subjected to a partial discharge test and an insulation resistance test for each reel. The partial discharge corona test shall be as outlined in ICEA standard S-68-516, AEIC CS6-96, and meet the following:

Vt/Vg Ratio	1.0	1.5	2.5	3.0	4.0
Maximum partical discharge in picocoulombs	5	5	5	5	10
Test voltage in KV for 5 KV Cable	3.0	4.5	7.0	8.5	11.5

See typical manufacturer's form attached.

The insulation resistance shall not be less than 50,000 megohm-1000 ft. at 60°F with an applied voltage of 23KVAC for 5 minutes.

The conductor shield, conductor shield-insulation interface, insulation, and insulation-insulation shield interface shall be tested according to AEIC No. CS6 to determine the size and magnitude of voids and contaminants. The contact area between the insulation and the shield extrusions shall be tested according to AEIC No. CS6 to determine the size of protrusions. The test results shall meet the requirements of AEIC No. CS6.

C. Certification shall be provided to show that test samples of cable insulated with the same insulating system as that to be supplied have been subjected to and passed the following test:

As described in ICEA S-68-516, Paragraph 6.23.3, with the energy source equal to a minimum of 250 volts/mil of insulation thickness, cable shall withstand this test for a minimum of 200 hours without failure. EPR cables employing single or double extrusions must apply this test and withstand it for a minimum of 200 hours. However, EPR cables employing triple tandem extrusion need not comply with this test.

The tests shall be made on #2 (7 stranded) AWG copper conductor insulated with an inner stress control layer and 175 mil minimum average wall of insulating material.

D. The conductor resistance and shield continuity shall be measured on each shipping length of cable and recorded. Each end of every shipping length shall also be inspected for water in strands and checked dimensionally for conformance with the above standards.

Each length of completed cable on the shipping reel shall be tested dry and shall pass an ac voltage withstand test applied for one minute at a test voltage of 24kV, and dc voltage test at 48 KV.

The insulation resistance shall again be measured according to the criteria stated above.

E. The Engineer reserves the right to witness all tests. Schedule of testing to be provided to the Owner two weeks before the test date.

F. Visual examination of both ends of every shipping length of cable shall be made to assure that no water is in the completed cable when shipped.

G. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

1.7 QUALIFICATIONS

A. All manufacturers shall have a minimum successful track record in production and use of their materials as proposed as follows:

Cable - 20 years
Terminations - 10 years
Splices - 10 years

B. Any workers performing splices or terminations on high voltage cable shall have a minimum of 10 years experience.

C. Contractor shall submit manufacturers and splicers experience as specified above including references to projects completed. Five (5) installations shall be provided and considered only if no failures have occurred.

1.8 CABLE APPROVAL: Submit the following for final approval:

A. Cable manufacturers certified test data, including full documentation package.

B. Two 2' samples of each cable, taken from reels at jobsite prior to installation. Reseal cable on reel. Additional samples may be required during the contract period. Include the following additional information on the sample labels; the maximum voltage at which the conductor is designed to be used, date of manufacturer. Certify ethylene content if EPR cable is furnished.

C. Samples of all splicing and termination materials. Samples of complete kits will be returned and if approved may be used in the work. Samples shall include a full roll of all tapes in original box or container, with the date of manufacture indicated thereon, other materials in sufficient quantity to construct a complete splice and labeled for identification, entire factory packaged kit if splice or termination is of the kit type. Provide three (3) spare splice kits of each type to owner.

D. Written statement from cable manufacturer indicating recommended pulling compounds and pulling tensions.

E. Product Data: Submit manufacturer's catalog sheets for all products.

1.9 QUALITY ASSURANCE

A. Manufacturer's Representative: Secure the services of cable manufacturer's representative for minimum of 3 days (not necessarily consecutive) for the consultation on method of installing cable, inspection of equipment for installing cable, witness representative amount of cable pulling, witness construction of at least one splice and one termination by each cable splicer, certify to the Engineer in writing that the aforementioned particulars are satisfactory and the cable has been installed in accordance with cable manufacturer's recommendations.
If the splices or terminations are other than the cable manufacturer's, secure the services of the splice and termination manufacturer's representative to concurrently witness construction of the splices and terminations and also certify with an affidavit that the splices and terminations were constructed in accordance with the splice and termination manufacturer's recommendation.

1.10 TESTING COMPANY

Secure the services of one of the following companies for performing a high voltage after installation test on cables having a rated voltage of 5000 volts or higher:

A. Electrical Testing Laboratories, 2 East End Avenue, New York, N.Y. 10021, Phone No. 212-288-2600.

B. General Electric Co., Installation and Service Engineering Div., 3532 James Street, P.O. Box 1021, Syracuse, N.Y. 13201, Phone No. 315-456-7718.

C. Westinghouse Electric Corp., Apparatus Service Center, P.O. Box 270, Utica, N.Y. 13503, Phone No. 315-736-3021.

D. Advanced Testing Systems, Inc., P.O. Box 27, Carmel, N.Y. 10512, Phone No. 914-225-3110.

Submit names and addresses for approval of or equal companies.

1.11 MANUFACTURER'S REPRESENTATIVE

The cable manufacturer shall designate a Manufacturer's Representative to insure compliance with the provisions of the warranty specified in Section 1.12. The Manufacturer's Representative shall be designated by full name, title, business address, and telephone number. In the event of any change in representation, the manufacturer shall notify the Owner in writing as follows: **INSERT ADDRESS**

1.12 HIGH VOLTAGE CABLE WARRANTY

The cable manufacturer shall warranty the cable and installation as follows:

The cable manufacturer _____ (state manufacturer name) warrants solely to the _____ its successors and assigns, hereinafter collectively known as "Purchaser" that any wire or cable of its own manufacture ("Product") supplied for Project No.____ XX Project DESCRIPTION to follow XX will be free from defects in material and workmanship provided the wire and cable is employed under conditions contemplated and covered by the design specifications, and provided further that the wire and cable is installed, spliced, terminated, maintained and operated in accordance with the manufacturers recommended standards and procedures.

If a product fails electrically while in service, Purchaser shall notify the manufacturer within five (5) days of the discovery of such failure, and shall permit a representative of the manufacturer a reasonable opportunity to inspect the Product. If the failure is the result of defective material or workmanship, the manufacturer's sole responsibility under this Warranty shall be to repair or replace the defective Product, the choice of which will be at the manufacturer's option. If the manufacturer chooses to replace the defective Product, the new Product will be delivered free of charge to the above noted project site.

THE FOREGOING WARRANTY SUPPLEMENTS ALL OTHER WARRANTIES. THIS WARRANTEE SHALL BE EFFECTIVE FOR A PERIOD OF FORTY (40) YEARS FROM DATE OF ACCEPTANCE BY PURCHASER.

The manufacturer, in signing this document, additionally declares that they have inspected all installations, splices, terminations, tests, etc. and have deemed the installation acceptable. Any further testing by the purchaser will also be witnessed by the manufacturer.

This warranty is executed by an employee of the manufacturer with full authority to bind the manufacturer to the terms hereof.

_____
Name Title Date

Notary Public and Corporate Seal Required

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site.

B. Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.

C. Store and protect in accordance with manufacturer's instructions.

D. Protect from weather. Provide adequate ventilation to prevent condensation. Protect cable ends from moisture.

1.14 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of cable bank prior to rough-in.

C. Cable routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

2 PRODUCTS

2.1 MANUFACTURERS

A. Kerite.

B. Okonite.

2.2 CABLES IN DUCT BANK

A. Grouping shall be three (3) single conductor cables making up a 3-phase circuit, unless otherwise indicated on the drawings. Each cable shall consist of a copper conductor, semiconducting layer, insulation, semiconducting layer, shield, jacket separator, if required and outer jacket. Grounding wire shall be 600 volt insulated copper wire, type RHW, THW, THWN, or XHHW.

2.3 CABLE CONSTRUCTION

A. Cables shall be single conductors, shielded, jacketed. Keep ends of cables sealed at all times, except when making splices or terminations. Use heat shrinkable plastic end caps with sealant as manufactured by Raychem Corp., Thomas & Betts Co., or other methods approved by cable manufacturer. Cable shall be U.L. listed, type MV-90, and comply with U.L. 1072 Medium Voltage Cable.

B. Marking and Tagging: Mark and tag cables for delivery to the site. Entire length of cable shall be color labelled or color coded.

C. Date of Manufacture: No insulated cable OVER ONE YEAR OLD, FROM DATE OF MANUFACTURE WHEN INSTALLED, will be acceptable.

D. Conductor
1. The copper wire to be used for stranding shall be annealed uncoated in accordance with ASTM B-3 and B-8.
2. Central conductor shall be Class B concentric copper in accordance with the current ASTM Standard B-8.
3. The conductor sizes shall be from 2 AWG up to 1000 kcmil.

E. INSULATION - Insulation shall be as follows:
1. 1a. Kerite insulated conductors shall be rated 5KV between phases, ungrounded, 133% insulation level, Permashield insulation system shall consist of a permashield and a high temperature kerite (HTK) insulation, insulation shield, copper tape shield minimum 5.0 mils thick, uncoated, fabric separator tape over metal tape shield as required, outer heavy duty black jacket. Kerite insulated cable shall meet the intent for testing cables per ICEA S-68-516/NEMA WC-8. Manufacturer shall be Kerite Company, a subsidiary of Hubbel Corporation.

OR

1b. Ethylene Propylene Rubber (EPR) insulated conductors shall be rated 5 KV between phases, ungrounded 133% insulation level, insulation shall be a high-quality, heat, moisture, impact and ozone-resistant flexible thermosetting ethylene-propylene rubber based elastomer. The content of the elastomer used in the insulation compound shall not exceed 72% by weight of ethylene. The insulation shall be concentrically extruded directly over the semiconducting conductor shield.

2. All insulations must be compounded and mixed by the cable manufacturer in its own facilities to ensure maximum control and continuity of quality.

The insulation thickness on all conductor sizes 2 AWG through 1000 kcmil shall be 115 mils, and a minimum at any one point shall not be less than 90% of this value.

The insulation shield shall be an extruded semiconducting compound with a volume resistivity not in excess of 500 ohm-meters at 90° when tested per AEIC No. CS6. The insulation shield shall also be an ethylene propylene rubber, clean stripped and shall have a peel strength from the insulation between 6 and 18 lbs./0.5 inch width when tested per AEIC No. CS6.

Kerite insulated cables shall employ single extrusions while EPR cables shall be triple tandem extruded for conductor shield, insulation, and insulation shield.

Cables shall utilize a metallic tape shield, consisting of a 5.0 mil bare copper tape applied over the insulation shield. The tape shall be helically applied with a minimum overlap of 12-1.2%.

3. Cross linked polyethylene (XLP) insulated cables will not be accepted.

F. JACKET
1. The overall jacket over the copper shielding tape shall be heavy duty black (neoprene, Hypalon, or polyvinyl chloride) in accordance with ICEA S-68-516 (NEMA WC-8). The jacket thickness on complete size range from 2-1/0 AWG shall be 60 mils and for 2/0 - 1000 KC MIL shall be 80 mils for larger conductors.

G. The conductor temperatures shall not exceed 90°C (194°F) under normal operating temperature, 130°C (266°F) for emergency overload, and 250°C (482°F) for short circuit conditions.

H. Listing Agency: Cable types for which Underwriters Laboratories, Inc. provides product listing service shall be listed and bear the listing mark.

2.4 TERMINATIONS

A. Provide cable manufacturer's terminations. If cable manufacturer does not fabricate terminations, provide terminations by one of the manufacturers listed below if acceptable to the cable manufacturer. All materials shall be the standard product of one manufacturer. Ampere rating of termination shall not be less than ampere rating of cable. Voltage rating of termination shall not be less than voltage rating of cable.

B. Terminations

Elastimold 166CR elbow with test point and shield adapter.
G&W Slip-On Terminators.
Cooper Loadbreak Elbows, feed throughs and underground connection systems.
RTE
Mac Products

C. Hand applied terminations shall be 166CR elbow with test point and with voltage rated stress cones.

2.5 SPLICES

A. The high voltage cable splice shall be a factory engineered kit containing all necessary components to reinsulate the primary cable installation, metallic shielding/grounding system and overall jacket.

B. Each splice shall consist of a linear stress relief system with a high outer conductive layer for shielding.

C. Each splice shall pass the following electrical tests 1EEE-48-1975, and 1EEE-404-1986 and shall pass ANSI-C 119.2-1974 water immersion test. The splice manufacturer shall provide test reports demonstrating compliance with the above requirements.

D. All splices shall have the following ratings:

Voltage Class 5KV

Minimum corona extinction voltage less than or equal to 3pc at 13KV, for EPR cables.

AC with stand	1 minute	50KV	
DC with stand	15 minutes	75KV	
Impulse with stand	1.2 x 50	110KV	microseconds

Continuous current rating equal to cable capacity.

E. Furnish splices of type that are capable of being disconnected, deadened, or reconnected at future times without destruction to original splices. All materials shall be the standard product of one manufacturer. Ampere rating of splice shall not be less than ampere

rating of cable. Field made epoxy-resin unit are not acceptable. Provide one set of special tools required for the assembly of premolded splices to facility.

F. All applications:
Elastimold Premolded Splices
G & W Electric Specialty Co. Universal Splice System
Raychem Thermofit Heat-Shrinkable High Voltage Termination System.

G. All splice kits to be approved by cable manufacturers.

2.6 POTHEADS

A. Manufacturers:
1. G&W.
2. A.B. Chance Company

B. Description: IEEE 48; Class 1 termination. Pothead with porcelain insulators, cable connector and aerial lug, sealed cable entrance and support, and insulating compound.

C. Conductors: One.

2.7 CABLE DEAD ENDS (Full Voltage)

A. All applications:
Elastimold Premolded Splice with Dead-End Plug

2.8 PULLING COMPOUNDS

As recommended by cable manufacturer

2.9 ARC PROOFING TAPES

A. Arc Proofing Tape: 3M Scotch 7700; Plymouth Rubber Co. Plyarc; Quelcor Inc. Quelpyre;

B. Glass Cloth Tape: 3M Scotch No. 27; Plymouth Rubber Co. Plyglas;

C. Glass-Fiber Cord: 3M Scotch A-4; Quelcor Inc. Quelpyre 1/8" tying cord.

2.10 TAGS

A. Phenolic Type: Standard phenolic nameplates with 3/8" minimum size lettering engraved thereon.

B. Embossed Aluminum: Standard stamped or embossed aluminum tags: Tech Products, Inc., Seton Name Plate Corp.

3 EXECUTION

3.1 INSTALLATION

A. Provide and install all high voltage cables with all connections complete, as specified herein and as indicated on the drawings.

B. Install cables in conduit after conduit system is complete and cleaned.

C. Keep ends of cables sealed watertight at all times, except when making splices and terminations.

D. No grease, oil, lubricant other than approved pulling compound may be used to facilitate the pulling-in of cables.

E. Use pulling eye factory installed to conductor(s) for pulling in cables. Cable grip will not be allowed. Seal pulling eye attachment watertight.

F. Pull all cables with a dynamometer or strain gauge incorporated into the pulling equipment. Do not pull cables unless the designated representative is present to observe readings on the dynamometer or strain gauge during the time of actual pulling. Total strain shall not exceed manufacturers recommendations.

G. Splice and terminate primary cables in accordance with manufacturers approved installation instructions. Ground shield at all splices and terminations. Incorporate solder dam or other method to prevent moisture from entering splices through grounding conductor.

H. Arc Proofing - Arc proof new feeders installed in a common pullbox or manhole, arc proof existing feeders that are spliced to new feeders, arc proof each feeder as a unit with half-lapped layer of arc proofing tape and random wrapped or laced with glass cloth tape or glass-fiber cord.

I. Identification of Feeders: Identify feeders in manholes, pullboxes and in equipment to which they connect with phenolic or embossed aluminum tags:
Install tags on each insulated conductor indicating phase leg. Attach tags with non-ferrous metal wire. Install phase leg tags under arc proofing tapes. Install tags on each feeder indicating feeder number, date installed, (month, year), type of cable, voltage rating, size, manufacturer. Attach tags so that they are easily read without moving adjacent feeders or requiring removal of arc proofing tapes.

J. Phase Relationship: Connect feeders to maintain phase relationship through system. Phase legs of feeders shall match bus arrangements in equipment to which the feeders are connected.

K. High Voltage After Installation Test - Perform test after cable has been installed complete with all splicing, bonding, etc., and prior to placing cable into service. Perform test with potential and duration specified by the manufacturer after approval of manufacturers certified test data. Test methods shall be in accordance with latest applicable ICEA and AEIC Specification. Do not make tests until test voltages and duration have been specified in writing by the manufacturer. List results of the tests on standard form supplied by the testing company. Leakage during test shall be read on a micro-ammeter. Perform test in the presence of the Designated Representative. Send results to Engineer and manufacturer for approval and Designated Representative for informational purposes.

L. Avoid abrasion and other damage to cables during installation.

M. Sustain cable pulling tensions and bending radii below manufacturer’s recommended limits.

N. Ground cable shield at each termination and splice.

O. Install cables in manholes along wall providing longest route.

P. Arrange cable in manholes to avoid interference with duct entrances.

Q. Use suitable manufacturer approved lubricants and pulling equipment.

3.2 PREPARATION

A. Use swab to clean conduits and ducts before pulling cables.

3.3 EXISTING WORK

A. Remove abandoned medium-voltage cable.

B. Ensure access to existing medium-voltage cable and other installations which remain active and which require access. Modify installation or provide access panel as appropriate.

C. Extend existing medium-voltage cable installations using materials and methods compatible with existing electrical installations.

D. Clean and repair existing medium-voltage cable which remain or is to be reinstalled.

3.4 INSTALLATION TESTING

A. Sample Field Test Instructions - Direct current acceptance tests on cable after installations (Hi-Potential Proof Test).

B. After installation and prior to connecting into service, test cables with a direct potential of 35KV for fifteen (15) consecutive minutes.

Test Procedure

1. Set up test equipment. Do not connect test lead to cables, but temporarily hang the lead free with a plastic bag over the clip. Raise the voltage to the same final level at which the cables are to be tested. The leakage current seen on the DC meter is leakage in the test lead, and should be subtracted from the readings taken later during the cable test. Shut the set off and discharge the lead.
2. Clear the circuit of any connected equipment so as to preclude damage to such equipment during the test, i.e., remove pothead taps, disconnect transformers, accessible switch taps, etc.
3. Seal and protect cable ends from moisture to prevent high leakage readings.
4. Check that adequate clearance exists between the circuit ends under test and ground and to other equipment to prevent flashovers.
5. Megger cable with minimum 1000 volts.
6. Perform insulation resistance test phase to phase and phase to ground on all cables. If satisfactory, proceed with current leakage test.
7. Ground circuit phases not under test.
8. Apply the direct current voltage slowly, increasing in steps of 10KV. Record the micro-ampere leakage at each step. When the specified test voltage is reached, record current leakage at required durations on current leakage test chart.

9. Reduce test voltage control to zero. Permit residual voltage on circuit to reduce to about 50% to 20% of test value before discharging by application of manual grounds.
10. Repeat steps "4" to "9" for remainder of phases of each feeder to be tested.
11. It should be recognized that d.c. charges remaining on a cable can build up to potentially dangerous voltages if grounds have not been applied for a sufficient length of time. The cable shall remain grounded for as long a period as possible but, in no case, for less than one hour.
12. Copies of all hi-potential proof tests shall be sent to the following parties within three (3) working days after the test via first class mail.
    a. Engineer;
    b. Facility Superintendent;
    c. Cable Manufacturer.

C. If the cable does not pass any of the tests, the contractor and manufacturer shall remedy the situation and/or replace defective cable. If not, installation will not be accepted.

D. An additional high potential proof test will be required one month before one year has passed since original acceptance. Test results shall be sent to owner for approval.

END OF SECTION 26 05 13

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

1 GENERAL

1.1 WORK INCLUDED

A. Section Includes:
1. Rod electrodes.
2. Wire.
3. Grounding well components.
4. Mechanical connectors.
5. Exothermic connections.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
1. Metal underground water pipe.
2. Metal building frame.
3. Concrete-encased electrode.
4. Ground ring as indicated on the drawings.
5. Rod electrode.
6. Plate electrode.

1.4 DESIGN REQUIREMENTS

A. Construct and test grounding systems for access flooring systems on conductive floors accordance with IEEE 1100.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum at twenty (20') feet.

1.6 SUBMITTALS

A. Product Data: Submit data on grounding electrodes and connections.

B. Test Reports: Indicate overall resistance to ground.

C. Manufacturer's Installation Instructions: Submit for active electrodes.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and grounding electrodes.

1.8 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with State of New York standards.

C. Maintain one (1) copy of each document on site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three (3) years documented experience.

1.10 PRE-INSTALLATION MEETINGS

A. Convene minimum one (1) week prior to commencing work of this section.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.12 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
1. Apache Grounding/Erico Inc.
2. Copperweld, Inc.
3. Erico, Inc.
4. O-Z Gedney Co.

5. Thomas & Betts.

B. Product Description:
1. Material: Copper-clad steel.
2. Diameter: 5/8" inch.
3. Length: 10 feet.

C. Connector: Connector for exothermic welded connection.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: #2/0 AWG, Ground Grid #4/0 AWG bare.

C. Grounding Electrode Conductor: Copper conductor bare, size to meet NFPA 79 requirements.

D. Bonding Conductor: Copper conductor bare.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
1. Apache Grounding/Erico Inc.
2. Copperweld, Inc.
3. Erico, Inc.
4. ILSCO Corporation.
5. O-Z Gedney Co.
6. Thomas & Betts, Electrical.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld.
2. Erico, Inc.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

3 EXECUTION

3.1 EXAMINATION

A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

B. Extend existing grounding system using materials and methods compatible with existing electrical installations, or as specified.

3.4 INSTALLATION

A. Install in accordance with IEEE 142, 1100.

B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding and bonding conductors concealed from view.

D. Install grounding electrode conductor and connect to reinforcing steel in foundation footing as indicated on Drawings. Electrically bond steel together.

E. Bond together metal structures not attached to grounded structure; bond to ground.

F. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

G. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.

H. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, transformers switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

I. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

J. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.

K. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground resistance testing in accordance with IEEE 142.

D. Perform leakage current tests in accordance with NFPA 99.

E. Perform continuity testing in accordance with IEEE 142, using the fall-of-potential method and provide written report to the Engineer of the results.

F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION 26 05 26

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1 GENERAL

1.1 WORK INCLUDED

A. Work Included:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Firestopping relating to electrical work.
7. Firestopping accessories.
8. Equipment bases and supports.

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

B. Factory Mutual System:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL - Fire Resistance Directory.

E. 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 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
   1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

B. Surface Burning: ASTM E84, UL 723 with maximum flame spread/smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM, UL, WH for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

A. Shop Drawings: Indicate system layout with location and detail of hangers. All installations to adhere to seismic requirements.

B. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load carrying capacity of all hangers and supports.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Engineering Judgements: For conditions not covered by UL listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements and structural integrity of conduit, kindork, trapeze mounts, etc..

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with State of New York standards for electrical installations and seismic requirements.

B. Maintain one (1) copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three (3) years documented experience.

1.9 PRE-INSTALLATION MEETINGS

A. Convene minimum one (1) week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

C. Provide ventilation in areas to receive solvent cured materials.

2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.
3. O-Z Gedney Co.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Galvanized Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
1. Kindorf.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center. Provide stainless steel 12 gage thick in wet areas (basement of Blower Building).

2.3 SLEEVES

A. Furnish materials in accordance with State of New York standards.

B. Sleeves for conduit through Non-fire Rated Floors: 18 gage thick galvanized steel.

C. Sleeves for conduit through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

D. Sleeves for conduit through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

E. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.4 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. Substitutions:

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.5 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products.
6. Specified Technology, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.

7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

2.6 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.
4. Plywood or particle board.
5. Alumina silicate fire board.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
1. Furnish UL listed products or products tested by independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. 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 backing, damming materials to arrest liquid material leakage.

D. Obtain permission from Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide expansion anchors.

2. Steel Structural Elements: Provide beam clamps.
3. Concrete Surfaces: Provide expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.4 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.

D. Compress fibered material to maximum 40 percent of its uncompressed size.

E. Remove dam material after firestopping material has cured. Dam material to remain.

F. Fire Rated Surface:
1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
c. Pack void with backing material.
d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

2. Where conduit, wireway, and trough penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

G. Non-Rated Surfaces:
1. Seal opening through non-fire rated wall, partition, floor, ceiling, and roof opening as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
   b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
   c. Install type of firestopping material recommended by manufacturer.
2. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.
4. Interior partitions: Seal pipe penetrations at all rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3 inches thick with a 1" 45° chamfer and extending 3 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members formed steel channel. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with stuffing fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install stainless steel escutcheons at finished surfaces.

3.7 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

1 GENERAL

1.1 WORK INCLUDED

A. Section includes conduit wireways, outlet boxes, pull and junction boxes.

B. Related Sections:
1. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than five (5) feet outside Foundation Wall: Provide nonmetallic conduit.

C. Underground Within five (5) feet from Foundation Wall: Provide rigid steel conduit, into building.

D. In or Under Slab on Grade: Provide rigid steel conduit. Provide cast or nonmetallic metal boxes.

E. Outdoor Locations, Above Grade: Provide rigid metal conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes to match material.

F. In Slab Above Grade: Provide rigid steel conduit. Provide cast nonmetallic boxes.

G. Wet and Damp Locations: Provide rigid metal conduit. Provide cast metal or nonmetallic outlet, junction, and pull boxes to match material. Provide flush mounting outlet box in finished areas.

H. Concealed Dry Locations: Provide rigid steel conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

I. Exposed Dry Locations: Provide rigid steel conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes. Cable tray as indicated on the drawings is to be provided.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Product Data: Submit for the following:
1. Flexible metal conduit.
2. Nonmetallic conduit.
3. Raceway fittings.
4. Conduit bodies.
5. Pull and junction boxes.

B. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Record actual routing of conduits larger than two (2") inch trade size.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC conduit from sunlight.

1.8 COORDINATION

A. Coordinate installation of outlet boxes for equipment connected under **Section 16150.**

B. Coordinate mounting heights, orientation and locations of outlets.

2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:

1. Triangle.
2. Wheatland Tube COmpany.
3. Steel City.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.1 FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Greenfield.
2. AFC.

B. Product Description: Interlocked steel construction.

C. Fittings: NEMA FB 1.

2.2 NONMETALLIC CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Appleton.

B. Product Description: NEMA TC 2; Schedule 40, PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.3 WIREWAY

A. Manufacturers:
1. Hoffman.
2. Electromate.
3. The Austin Company.

B. Product Description: General purpose, Oiltight and dust-tight, Raintight type wireway.

C. Knockouts: Manufacturer's standard, None, Bottom only.

D. Size: 4 x 4 inch, 6 x 6 inch, 8 x 8 inch, 12 x 12 inch; length as indicated on Drawings.

E. Cover: Hinged cover with full gaskets.

F. Connector: Slip-in, Flanged.

G. Fittings: Lay-in type with removable top, bottom, and side; captive screws, drip shield.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

2.4 OUTLET BOXES

A. Manufacturers:
1. Appleton.

2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Crouse Hinds.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

E. Wall Plates for Finished Areas: As specified in Section 16140.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.1 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Appleton.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Crouse Hinds.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 16131.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4, 4X, 6; flat-flanged, surface mounted junction box:
1. Material: Galvanized cast iron, Cast aluminum.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. In-Ground Cast Metal Box: NEMA 250, Type 6, outside, inside flanged, recessed cover box for flush mounting:
1. Material: Galvanized cast iron, Cast aluminum.
2. Cover: Smooth, Nonskid cover with neoprene gasket and stainless steel cover screws.
3. Cover Legend: "ELECTRIC".

3 EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

A. Remove exposed abandoned raceway. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Maintain access to existing boxes and other installations remaining active and requiring access.

D. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing raceway and boxes to remain.

3.3 INSTALLATION

A. Install Work in accordance with NECA - “Standards of Installation.”

B. Ground and bond raceway and boxes in accordance with Section 260526.

C. Fasten raceway and box supports to structure and finishes in accordance with Section 16070.

D. Identify raceway and boxes in accordance with Section 260553.

E. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 16070; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 16070.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route conduit in and under slab from point-to-point.

J. Maximum Size Conduit in Slab Above Grade: 3/4. Do not cross conduits in slab larger than 3/4 inch trade size.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

T. Install ½" pull or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Close ends and unused openings in wireway.

W. All conduits shall be rigid steel 6-inch above and below concrete floors, pads. Spray exposed surfaces with PVC.

3.5 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings specified in section for outlet device.

B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

F. Support boxes independently of conduit.

G. Install gang box where more than one device is mounted together. Do not use sectional box.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

A. Install knockout closures in unused openings in boxes.

3.8 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 26 05 33

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rigid nonmetallic duct.
2. Flexible nonmetallic duct.
3. Duct accessories.
4. Precast concrete handholes.
5. Polymer concrete handholes and boxes with polymer concrete cover.

1.2 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder step details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

D. Source quality-control reports.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube & Conduit; a part of Atkore International.
2. Calconduit.
3. O-Z/Gedney; a brand of Emerson Industrial Automation.
4. Southwire Company.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Underground Plastic Utilities Duct: Type DB-60 PVC and Type DB-120 PVC RNC, complying with NEMA TC 6 & 8 and ASTM F 512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex Inc.
4. ElecSys, Inc.

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.3 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ARNCO Corp.
b. Carlon; a brand of Thomas & Betts Corporation.
c. National Pipe & Plastics.
d. Opti-Com Manufacturing Network, Inc (OMNI).

B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; a part of Atkore International.
b. Cantex Inc.
c. Carlon; a brand of Thomas & Betts Corporation.
d. IPEX USA LLC.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armorcast Products Company.
2. Hubbell Incorporated (Power Systems Group - Quazite).
3. NewBasis.
4. Oldcastle Enclosure Solutions.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Green.

E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, as indicated for each service.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, concrete-encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.

C. Duct for Electrical Branch Circuits: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways: RNC Type EPC-40 PVC, encased in reinforced concrete.

E. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

J. Pulling Cord: Install 200-lbf test nylon cord in empty ducts.

K. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
6. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
8. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
10. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

1 GENERAL

1.1 WORK INCLUDED

A. Work Included:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Stencils.
6. Underground Warning Tape.
7. Lockout Devices.

1.2 SUBMITTALS

A. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

B. Samples:
1. Submit two (2) samples of each type of identification products applicable to project.

2. Submit two (2) nameplates, 4 x 4 inch in size illustrating materials and engraving quality.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with State of New York standard.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three (3) years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three (3) years documented experience approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept identification products on site in original containers. Inspect for damage.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Install nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

1.8 EXTRA MATERIALS

A. Furnish two (2) containers of spray-on adhesive.

2 PRODUCTS

2.1 NAMEPLATES

A. Furnish materials in accordance with State of New York standards.

B. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

C. Letter Size:
1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.
3. inch high letters for identifying

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Furnish materials in accordance with State of New York standards.

B. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

A. Furnish materials in accordance with State of New York standards.

B. Description: Split sleeve or tubing type wire markers.

C. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams or shop drawings.

2.4 CONDUIT AND RACEWAY MARKERS

A. Furnish materials in accordance with State of New York standards.

B. Description: Nameplate fastened with straps.
C. Color:
1. Medium Voltage System: Black lettering on white background.

2. 480 Volt System: White lettering on black background.
3. 208 Volt System: White lettering on black background.
4. Fire Alarm System: Red lettering on white background.
5. Intercom System: Blue lettering on white background.

D. Legend:
1. Medium Voltage System: HIGH VOLTAGE FEEDER "_____".
2. 480 Volt System: 480 VOLTS.
3. 208 Volt System: 208 VOLTS.
4. Fire Alarm System: FIRE ALARM.
5. Telephone System: INTERCOM.

2.5 STENCILS

A. Furnish materials in accordance with State of New York standards.

B. Stencils: With clean cut symbols and letters of following size:
1. Up to 2 inches Outside Diameter of Raceway: 1/2 inch high letters.
2. 2-1/2 to 6 inches Outside Diameter of Raceway: 1 inch high letters.

C. Stencil Paint: Semi-gloss enamel, colors conforming to the following:
1. Black lettering on white background.

2.6 UNDERGROUND WARNING TAPE

A. Description: 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 EXISTING WORK

A. Install identification on existing equipment to remain in accordance with this section.

B. Install identification on unmarked existing equipment.

C. Replace lost nameplates, labels, and markers.

3.3 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.

3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
4. Secure nameplate to equipment front using screws or adhesive.
5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Install nameplates for the following:
   a. Switchboards.
   b. Panelboards.
   c. Transformers.
   d. Service Disconnects.
   e. Fire alarm.
   f. Switchgear.
   g. Transfer Switches.
   h. Intercom.
   i. Generators.

C. Label Installation:
1. Install label parallel to equipment lines.
2. Install label for identification of individual control device stations.
3. Install labels for permanent adhesion and seal with clear lacquer.

D. Wire Marker Installation:
1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.
2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
3. Install labels at data outlets identifying patch panel and port designation.

E. Conduit Marker Installation:
1. Install conduit marker for each conduit longer than 6 feet.
2. Conduit Marker Spacing: 20 feet on center.
3. Raceway Painting: Identify conduit using field painting
   a. Paint colored band on each conduit longer than 6 feet.
   b. Paint bands 20 feet on center.
   c. Color:
      1) 480 Volt System: Blue.
      2) 208 Volt System: Yellow.
      3) Fire Alarm System: Red.
      4) Intercom System: Green.

F. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION 26 05 53

SECTION 26 12 10

ELECTRICAL UTILITY SERVICES

1 GENERAL

1.1 SUMMARY

A. Section includes arrangement with Utility Company for permanent electric service; payment of Utility Company charges for service; service provisions; and utility metering equipment.

1.2 REFERENCES

1.3 SYSTEM DESCRIPTION

A. Utility Company: Consolidated Edison Company of New York. Contact: Mr. Robert Laboni (917) 662-0615.

B. System Characteristics: 480Y/277 volts (Commons and Assisted Living Buildings) and 208/120 volt (Independent Living Buildings), three phase, four- wire, 60 Hertz. Villas 240/120 volts, single phase, three-wire, 60 Hertz.

C. Service Entrance: Underground to pad mounted utility transformers.

1.4 SUBMITTALS

A. Submit Utility Company-prepared drawings. See Division of Responsibility and Service Layout at end of this section.

B. Submit Engineer approved shop drawings to Utility Company for their approval as required.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Utility Company written requirements.

B. Maintain one (1) copy of each document on site.

1.6 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings Utility Company drawings.

1.7 COORDINATION

A. Coordinate with utility company for underground lines interfering with construction. Where power lines are to be temporarily relocated, bill utility costs, directly to Owner.

B. Contact utility company regarding charges related to service installation. Include utility charges in this contract.

1.8 REGULATORY REQUIREMENTS

A. Confirm to requirements NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc., testing from acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 PRE-INSTALLATION MEETING

A. Convene at least one (1) week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative.

2 PRODUCTS

2.1 UTILITY METERS

A. Furnished by Utility Company.

2.2 METERING TRANSFORMER CABINET

A. Manufacturers: Must be an Utility approved manufacturer.

B. Size: As required by Utility.

C. Description: Sheet metal cabinet with hinged door conforming to Utility Company requirements, with provisions for locking and sealing with fused main service disconnect.

2.3 TRANSFORMER PAD

A. Manufacturers: Must be an Utility approved manufacturer.

B. Product Description: Fiberglass reinforced plastic or cast-in-place concrete. Precast concrete transformer pad with cable pit sized as required by the Utility Company.

1 EXECUTION

1.1 EXAMINATION

A. Verify service equipment is ready to be connected and energized.

1.2 EXISTING WORK

A. Remove exposed abandoned service entrance raceway and conductors, including abandoned components above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Disconnect abandoned service equipment and remove.

C. Maintain access to existing service equipment, boxes, metering equipment, and other installations remaining active and requiring access. Modify installation or provide access panel.

D. Extend existing service installations using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing service equipment to remain or to be reinstalled.

1.3 INSTALLATION

A. Install metering transformer cabinets, transformer pad, customer utility pole at height in accordance with Utility Company requirements. Install drip loop in service conductors.

END OF SECTION 26 12 10

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SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

1 GENERAL

1.1 SUMMARY

A. Section includes two-winding transformers; two-winding transformers rated for nonlinear loads, and buck-and-boost transformers.

B. Related Sections:
   1. Section 260533 - Conduit: Flexible conduit connections.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
   2. NEMA ST 20 - Dry Type Transformers for General Applications.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   2. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

A. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.4 SUBMITTALS FOR INFORMATION

A. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

B. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of transformers.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

2 PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:
1. ACME Transformers.
2. General Electric Model QL.
3. Square D.

B. Product Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers, ratings as indicated on Drawings.

C. Primary Voltage: 480 volts, 3 phase, 3 wire..

D. Secondary Voltage: 208Y/120 volts, 3 phase, 4 wire.

E. Insulation system and average winding temperature rise for rated kVA as follows:
1. 1-15 kVA: Class 185 with 115 degrees C rise.
2. 16-500 kVA: Class 220 with 150 degrees C rise.

F. Case temperature: Do not exceed 50 degrees C rise above ambient at warmest point at full load.

G. Winding Taps:
1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

H. Sound Levels: NEMA ST 20. Maximum sound levels are as follows for 150°C rise:
1. 0-9 kVA: 40 dB.
2. 10-50 kVA: 45 dB.
3. 51-150 kVA: 50 dB.
4. 151-300 kVA: 55 dB.
5. 301-500 kVA: 60 dB.

I. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.

J. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.

K. Mounting:
1. 1-15 kVA: Suitable for wall mounting.

2. 16-75 kVA: Suitable for, floor mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

L. Coil Conductors: Continuous copper windings with terminations brazed or welded.

M. Enclosure: NEMA ST 20, Type 1. Furnish lifting eyes or brackets.

N. Isolate core and coil from enclosure using vibration-absorbing mounts.

O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 TWO-WINDING TRANSFORMERS RATED FOR NONLINEAR LOADS

A. Manufacturers:
1. General Electric Model QL.
2. ACME.
3. Square D.

B. Product Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers, ratings as indicated on Drawings designed to supply a 100 percent nonlinear load.

C. Primary Voltage: 480 volts, 3 phase, 3 wire..

D. Secondary Voltage: 208Y/120 volts, 3 phase, 4 wire.

E. Core Flux Density: Below saturation at 10 percent primary overvoltage.

F. Insulation system and temperature rise: Class 220 insulation system with 150 degrees C average winding temperature rise.

G. Case temperature: Do not exceed 50 degrees C rise above ambient at warmest point at full load.

H. Winding Taps:
1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

I. Sound Levels: NEMA ST 20. Maximum sound levels are as follows for 150°C rise:
1. 0-9 kVA: 40 dB.
2. 10-50 kVA: 45 dB.
3. 51-150 kVA: 50 dB.
4. 151-300 kVA: 55 dB.
5. 301-500 kVA: 60 dB.

J. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.

K. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.

L. Mounting:
1. 1-15 kVA: Suitable for wall mounting.
2. 16-75 kVA: Suitable for wall mounting.

3. Larger than 75 kVA: Suitable for floor mounting.

M. Coil Conductors: Continuous windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.

N. Electrostatic Shield: Copper, between primary and secondary windings.

O. Enclosure: NEMA ST 20, Type 1. Furnish lifting eyes or brackets.

P. Isolate core and coil from enclosure using vibration-absorbing mounts.

Q. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.1 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA ST20.

3 EXECUTION

3.1 EXAMINATION

A. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 EXISTING WORK

A. Disconnect and remove abandoned transformers.

B. Maintain access and adequate ventilation to existing transformers and other installations remaining active and requiring access and ventilation. Modify installation or provide access panel or ventilation grilles.

C. Clean and repair existing transformers to remain or to be reinstalled.

3.3 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, in accordance with Section 260519, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

D. Provide seismic restraints.

E. Install grounding and bonding in accordance with Section 16060.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.5 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 26 22 13

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SECTION 26 24 13

SWITCHBOARDS

1 GENERAL

1.1 SUMMARY

A. Section includes 600 volt class main and distribution switchboards.

B. Related Sections:
1. Section 260526 - Grounding and Bonding.
2. Section 260553 - Electrical Identification.

1.2 REFERENCES

A. ANSI C12.1 - Code for Electricity Metering.

B. ANSI C39.1 - Electrical Analog Indicating Instruments.

C. ANSI C57.13 - Instrument Transformers.

D. IEEE C62.41 (Institute of Electrical and Electronics Engineers) - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

E. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers.

F. NEMA KS 1 (National Electrical Manufacturers Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

G. NEMA PB 2 (National Electrical Manufacturers Association) - Dead Front Distribution Switchboards.

H. NEMA PB 2.1 (National Electrical Manufacturers Association) - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

I. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.

B. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

C. Test Reports: Indicate results of factory production and field tests.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

B. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in individually wrapped for protection and mounted on shipping skids.

B. Accept switchboards on site. Inspect for damage.

C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 SEQUENCING

A. Sequence Work to avoid interferences with building finishes and installation of other products.

2 PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

A. Manufacturers:
   1. Square D. (Design Basis)
   2. Siemens.
   3. General Electric.

B. Product Description: NEMA PB 2, enclosed switchboard with electrical ratings and configurations as indicated on Drawings, 600 volt class.

A. Bus:
   1. Material: Copper, standard size.
   2. Connections: Bolted, accessible from front for maintenance.
   3. Insulation: Fully insulate load side bus bars.

B. Ground Bus: Extend length of switchboard.

C. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on Drawings.

D. Enclosure: Type 1 - General Purpose.

E. Align sections at front and rear.

F. Switchboard Height: 90 inches.

G. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

H. Mimic Bus: Show bussing, connections and devices in single line form on front panels of switchboard using black color plastic strips, fastened flat against panel face with adhesive.

I. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Furnish interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: designed to accommodate NEMA FU 1, Class J fuses. Match manufacturer.

J. Molded Case Circuit Breaker: to match manufacturer.

   1. Product Description: NEMA AB 1, molded-case circuit breaker.

   2. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 200 amperes and larger have mechanism for adjusting long time, short time, continuous current, setting for automatic operation.

K. Provide digital monitor for amps, volts, power, etc.

L. Accessories: Conform to NEMA AB 1.

M. Metering Transformers

1. Current Transformers: ANSI C57.13; 5 ampere secondary, with single secondary winding and secondary shorting device, 60 Hertz.

2. Potential Transformers: ANSI C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, 60 Hertz.

2.2 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing in accordance with NEMA PB 2.

B. Make completed switchboard available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least seven days before inspections and tests are scheduled.

3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install fuses in each switch and coordinate sizes with connected load. Provide three (3) spare fuses of each type.

D. Install engraved plastic nameplates in accordance with Section 260553.

E. Install breaker circuit directory.

F. Ground and bond switchboards in accordance with Section 260526.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.3 ADJUSTING

A. Adjust operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections.

C. Adjust circuit breaker trip and time delay settings to values as provided by coordination study.

3.4 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 26 24 13

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SECTION 26 24 16

PANELBOARDS

1 GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards, electronic grade branch circuit panelboards, and load centers.

B. Related Sections:
1. Section 260526 - Grounding and Bonding.
2. Section 260553 - Electrical Identification

1.2 REFERENCES

A. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

B. NECA Standard of Installation (published by the National Electrical Contractors Association).

C. Institute of Electrical and Electronics Engineers:
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

D. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
6. NEMA PB 1 - Panelboards.
7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

E. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

G. Underwriters Laboratories Inc.:
1. UL 67 - Safety for Panelboards.
2. UL 1283 - Electromagnetic Interference Filters.
3. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

B. Product Data: Submit catalog data showing specified features of standard products.

1.4 SUBMITTALS FOR INFORMATION

A. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.

1.7 MAINTENANCE MATERIALS

A. Furnish two (2) of each panelboard key. Panelboards keyed alike to Owner's current keying system.

2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:
1. Square D.
2. Siemens.
3. General Electric.
4. Eaton.

B. Product Description: NEMA PB 1, circuit breaker type panelboard. Furnish combination controllers as indicated on Drawings.

C. Service Conditions:
1. Temperature: 104 degrees F.
2. Altitude: 3300 feet above sea level.

D. Panelboard Bus: Copper, current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

E. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 240 and 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated on Drawings.

F. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Furnish interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate NEMA FU 1, Class J, fuses.

G. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

H. Molded Case Circuit Breakers with Current Limiters: NEMA AB 1, circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

I. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.

J. Controllers: NEMA ICS 2, AC general-purpose Class A [magnetic] [solid-state] controller for induction motors rated in horsepower.
1. Two-speed Controllers: Include integral time delay transition between FAST and SLOW speeds.
2. Full-voltage Reversing Controllers: Include electrical interlock [and integral time delay transition] between FORWARD and REVERSE rotation.
3. Control Voltage: 120 volts, 60 Hertz.
4. Overload Relay: NEMA ICS 2; bimetal.
5. Auxiliary Contacts: NEMA ICS 2, 2 each field convertible contacts in addition to seal-in contact.
6. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty type.
7. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150
8. Pushbuttons: Covered type.
9. Indicating Lights: , LED type.
10. Selector Switches: Rotary type.
11. Relays: NEMA ICS 2,

K. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.

L. Enclosure: NEMA PB 1, Type 1 cabinet box.

M. Cabinet Front: Surface door-in-door type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. GE Electrical.
2. Siemens.
3. Square D.
4. Eaton.

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper, current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard; furnish insulated ground bus as indicated on Drawings.

D. For non-linear load applications subject to harmonics furnish 200 percent rated, plated copper, solid neutral.

E. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 240 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated on Drawings.

F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter or arc fault circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.

G. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.

H. Enclosure: NEMA PB 1, Type 1 Type 3R.

I. Cabinet Box: 6 inches deep, 20 inches wide [for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.

J. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock keyed alike. Front cover of enclosure to bolt onto backbox and shall have an exposed piano hinge separate from circuit breaker cover. To open wiring compartment, unbolt only designated bolts, the remainder to remain and open cover by hinges. Finish in manufacturer's standard gray enamel.

2.1 LOAD CENTERS

A. Manufacturers:
1. General Electric.
2. Siemens.
3. Square D.
4. Eaton.

B. Product Description: Circuit breaker load center, with bus ratings as indicated on Drawings.

C. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical.

D. Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for poles, listed as Type SWD for lighting circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.

E. Enclosure: General Purpose.

F. Box: Flush type with door, and lock on door. Finish in manufacturer's standard gray enamel.

3 EXECUTION

3.1 INSTALLATION

A. Install panelboards and load centers in accordance with NEMA PB 1.1.

B. Install panelboards and load centers plumb.

C. Install recessed panelboards and load centers flush with wall finishes.

D. Height: 6 feet to top of panelboard and load center; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard and load center. Revise directory to reflect circuiting changes to balance phase loads.

G. Install engraved plastic nameplates in accordance with Section 260553.

H. Install spare conduits out of each recessed panelboard to accessible location [above ceiling] [below floor]. Minimum spare conduits: 5 empty 1 inch. Identify each as SPARE.

I. Ground and bond panelboard enclosure according to Section 260526. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

C. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

D. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.3 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within twenty (20%) percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 26 24 16

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SECTION 26 27 26

WIRING DEVICES

1 GENERAL

1.1 WORK INCLUDED

A. Section includes wall switches; receptacles and device plates.

B. Related Sections:
1. Section 260533 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
3. NECA - Standard of Installation.
4. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

B. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.

1.5 EXTRA MATERIALS

A. Furnish two (2) of each style, size, and finish wall plate.

B. Provide ten (10) spare wiring devices for each specified.

2 PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

F. Wall Plate Color: For plastic covers, match device color.

2.2 WALL SWITCHES

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Pass & Seymour.

B. Product Description: NEMA WD 1, Heavy-Duty, General-Duty, AC only general-use snap switch.

C. Body and Handle: Brown plastic with toggle rocker handle.

D. Indicator Light: Separate pilot strap; red color lens.

E. Ratings:
1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

2.3 STANDARD-GRADE RECEPTACLES, 125 V, 15 A

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Pass & Seymour.

B. Product Description: NEMA WD 1, Heavy-duty general use receptacle.

C. Device Body: Brown plastic.

D. Configuration: NEMA WD 6, type as indicated on Drawings.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

G. Telephone Jack: RJ11

2.4 TAMPER-RESISTANT DUPLEX RECEPTACLES, 125 V, 15 A

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Pass & Seymour.

B. Product Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.

C. Configuration: NEMA WD 6, type as indicated on Drawings.

D. Convenience Receptacle: Type 5-20.

E. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

F. Telephone Jack: RJ11

2.5 WALL PLATES

A. Manufacturers:
1. Arrow Hart Wiring Devices.
2. Eagle Electric.
3. Siemens Co.
4. Square D.
5. Snap Power – GudeLight2 (LED wall plate)

B. Jumbo Cover Plate: 302 stainless steel.

C. Weatherproof Cover Plate: Stainless steel plate with threaded and gasketed device cover.

3 EXECUTION

3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

D. Allow 10 foot location change for all devices.

3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 EXISTING WORK

A. Disconnect and remove abandoned wiring devices.

B. Modify installation to maintain access to existing wiring devices to remain active.

C. Clean and repair existing wiring devices to remain or to be reinstalled.

3.4 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.

C. Install receptacles with grounding pole on top.

D. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

J. Install LED wall plates for bathroom receptacles in the Independent Living and Assisted Living/ Memory Care apartment bathrooms.

K. Install tamper-resistant duplex receptacles in the Independent Living and Assisted Living Building's residential units.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 16130 to obtain mounting heights as specified and as indicated on drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 24 inches above finished floor.

3.6 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 26 27 26

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SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600-V ac.
4. 1200 A and smaller.

5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

PART 3 - EXECUTION

3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 with cover attached by Type 316 stainless steel bolts.

3.2 INSTALLATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

B. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

D. Comply with mounting and anchoring requirements

E. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in fusible devices.

G. Comply with NFPA 70 and NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 28 16

SECTION 26 32 13

PACKAGED ENGINE GENERATOR SYSTEMS – DIESEL OUTDOOR

PART 1 - GENERAL

1.1 CODES AND STANDARDS

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards:

1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings.

2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

3. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

4. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The generator set and supplied accessories shall meet the requirements of the following standards:

1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.

2. UL1236 – Battery Chargers.

3. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The control system for the generator set shall comply with the following requirements.

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.

2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.

3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.

4. FCC Part 15, Subpart B.

5. IEC8528 part 4. Control Systems for Generator Sets.

6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.

7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.

8. UL1236 –Battery Chargers.

D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.2 SUBMITTALS

A. Shop Drawings - Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

B. Product Data - Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, microprocessor control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, trailer and radiator.

C. Prototype Test Reports - Submittals will not be received without submission of prototype test report as specified herein.

D. Manufacturer’s Installation Instructions - Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

E. Manufacturer’s Certificate - Certify that Products meet or exceed specified requirements.

F. Alternator data indicating sub transient reactance and temperature rise rating to meet requirements specified herein.

1.3 OPERATION AND MAINTENANCE

A. Manuals - Furnish four operation and maintenance manuals.

1. Operation & Maintenance Data - Include instructions for routine maintenance requirements, service manuals for engine, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.4 QUALITY ASSURANCE

A. To provide proven reliability of the Generator set, three series of tests shall be performed, no exceptions taken:

1. Prototype model tests
2. Fully assembled factory production model tests
3. Field acceptance tests

B. The manufacturer shall provide documentation demonstrating satisfactory prototype and production test results. Generator sets that have not been prototype tested and Factory Production tested as described herein shall not be acceptable.

C. Generator Set Prototype Tests - These tests and evaluations must have been performed on a prototype generator set representative of the model specified. A summary of the generator set testing results shall be submittal for review. The manufacturer's standard series of components development tests on the generator system, engine and other major components shall be performed and available for review, but shall not be acceptable as a substitute for a prototype testing on the complete representative generator set prototype.

D. Torsiograph Analysis and Test - The manufacturer of the generator set shall verify that the engine generator set, as configured, is free from harmful torsional stresses. The analysis shall include correlation of empirical data from tests on a representative prototype. The empirical data must include spectrum analysis of the torsional transducer output within the operating speed range of the engine generator set. Calculations based on engine and generator separately are not acceptable.

E. Temperature Rise Test - Complete thermal evaluation of a prototype generator rotor and starter must include actual measurement of internal generator and exciter temperatures by embedded detector method, and measurement of average temperature rise by resistance method. No position measured any place in the windings may exceed the temperature rise limits of NEMA for the particular type of insulation system used. Resistance method temperature rise data shall be confirmed by a full load test on the generator set prototype to include conducted and radiated heat from the engine.

F. Short Circuit Test - A test on a prototype generator set shall have demonstrated that the generator set is designed to withstand the mechanical forces associated with a short circuit condition. With the generator set operating at rated load and speed, the generator terminals must be short circuited on all three phases for a duration of 20 seconds. At the conclusion of this test, the generator set must be capable of full load operation.

G. Endurance Run Test - A minimum of 500 continuous hours of endurance testing with a representative generator set prototype operating as defined by the manufacturer's standby rating shall have been performed. Endurance testing shall be used to verify structural soundness and durability.

H. Maximum Power Test - With the prototype generator set at normal operating temperature and with all power consuming auxiliaries in place, the maximum power available at rated speed shall be determined with the governor set at its fuel stop. The generator set shall maintain this power for a minimum of 2 minutes.

I. Linear Vibration Test - A test for in-line motion of components occurring along a repeatable path shall meet the manufacturer's acceptable criteria.

J. Cooling System Test - A cooling system test shall demonstrate the ability of the generator set cooling system to maintain normal operating temperature while operating at full rated load and power factor at the highest ambient temperature (122 degrees F) of the system rating. Cooling air requirements, radiator air flow and maximum allowable restriction at radiator discharge shall be verified by this test.

K. Maximum Motor Starting KVA Test - Motor starting KVA shall be determined by test, based on a sustained RMS recovery voltage of at least 90 percent on no load voltage with the specified load KVA at near zero power factor applied to the generator set.

L. Transient Response, Steady State Speed Control and Voltage Regulation Test - Prototype generator set tests shall demonstrate consistent performance as follows; stable voltage and

frequency at all loads from no load to full rated load, consistent frequency kp on load acceptance and rejection and restoration to steady state after sudden load changes. Transient response is a complete generator set (engine, generator, exciter, and regulator) performance criteria and cannot be established on generator data alone.

M. Witness-Generator Set Factory Production Tests - On the equipment to be shipped, an five-hour test shall be performed at rated load and 0.8 PF. These tests shall include certified data to document the following: run at full load, maximum power, voltage regulation, transient and steady state governing, single step load pickup and safety shutdowns. Provide a factory test record of the production testing. The Contractor and/or equipment supplier at their expense shall coordinate and provide all transportation and lodging for the owner and Owner's engineering representative to witness the above stated factory test. Tests performed at facilities other than the manufacturer's factory shall not be acceptable.

N. Factory Test - The unit shall be completely assembled and all preliminary adjustments made before the test is initiated. A 300 KW genset shall be tested with the complete radiator and fan assembly to be shipped. Outside radiator heat exchanger attachments shall not be acceptable!

O. Testing Procedure - Test diesel-alternator unit at 0.8 PF in the following sequence:

1. 1.0 hour at 1/4 load.
2. 1.0 hours at 1/2 load.
3. 1.0 hours at 3/4 load.
4. 2 hours at full load.

P. Above testing shall be strip chart recorded and certified. During this test, the following measurements shall be taken and recorded on a certified report format:

1. Barometric pressure.
2. Intake air pressure.
3. RPM.
4. Output voltage per phase.
5. Output amperes per phase.
6. Power factor.
7. KW.
8. Transient response testing sequence:
9. 0-25 percent, 25 percent-0.
10. 0-50 percent, 50 percent-0.
11. 0-75 percent, 75 percent-0.
12. 0-100 percent, 100 percent-0.

Q. Above testing shall be strip chart recorded. Provide necessary equipment and instruments to measure voltage dips and frequency dips. Comparison shall be made to the herein specified alternator performance characteristics prior to acceptance.

R. Field Acceptance Tests - Generator supplier shall provide and conduct a four-hour loadbank test at unity power factor for the generator set. Contractor must provide portable loadbank for testing generator set at 100 percent load. Load bank test shall test each generator at full nameplate KW ratings. Generator manufacturer's representative shall record test data, as described below. Test data shall be tabulated and typed for submission and approval by the engineer for final acceptance. No handwritten field notes will be allowed.

S. Initial start up andfield acceptance tests are to be conducted by the authorized representative of the system manufacturer who supplies the equipment. Contractor responsible for protection of testing equipment and any additional cable, etc., required if equipment cannot be located internally during testing.

T. Test data shall be collected and recorded on the following: Time of day, coolant temperature, operating oil pressure, battery charging rate, cranking time, crank-to-rated frequency time, voltage and frequency overshoot, load assumption-to-steady state voltage and frequency stabilization time, operating voltage, frequency, current, kilowatts and power factor. All data shall be taken every 15 minutes.

1.5 QUALIFICATIONS

A. Manufacturer - Company specializing in manufacturing the Products specified in this section with minimum 10 years' documented experience, and with an authorized distributor offering 24 hour parts and service availability within 50 miles of the project. Proposed engine/generator combination shall have been in production a minimum of 5 years.

B. Supplier - Authorized distributor of specified manufacturer with minimum five years' documented experience with specified products and factory-trained service technicians.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70, NFPA 110, and NFPA 101.

B. Furnish Products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

1.7 PRE-INSTALLATION CONFERENCE

A. Convene one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site.

B. Accept unit on site mounted on trailer. Inspect for damage. Provide written verification that genset tested and genset received are one and the same.

C. Protect equipment from dirt and moisture by securely wrapping in heavy plastic during construction

1.9 EXTRA MATERIALS

U. Provide two of each fuel, oil and air filter element, engine belts and hoses.

1.10 WARRANTY

A. A no deductible comprehensive warranty shall be provided for all products against defects in materials and workmanship for a 5-year or 1,500-hour period from the start-up date. Warranty shall cover all costs of covered repairs, including travel expenses.

1.11 SERVICE AGREEMENT

A. Manufacturer shall provide Owner with a two-year service agreement that includes changing all fluids and filters once a year and a minor inspection six months after each change.

PART 2-PRODUCTS

2.1 MANUFACTURERS

A. Approved manufacturer - Cummins Power Generation, Model DQFAA rated for STANDBY POWER with HC6J Frame Alternator as distributed by Cummins Power Generation, 6193 Eastern Avenue, Syracuse, NY 13211. Contact Ed Cheung: 718-502-1217.

B. It is intended that all products specified herein be of standard ratings, therefore, the KW and KVA, starting KVA and maximum allowable voltage dip, ratings, etc., shall be the manufacturer's next size or rating to exactly meet the specifications. No exceptions.

2.2 DIESEL ENGINE-GENERATOR SET

A. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of 480 Volts AC, 3-phase, 4-wire, 60 hertz.

2. The generator set shall be rated at 750 kW, 937.5 kVA at 0.8 PF, standby rating, based on site conditions of altitude 1,000 feet, ambient temperatures up to 122 degrees F (50 degrees C).

B. Performance

1. Voltage regulation shall be $\pm$0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed $\pm$0.5 percent.

2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed $\pm$0.25 percent.

3. The diesel engine-generator set shall accept a single step load of 100 percent

nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

4. Motor starting capability shall be a minimum of 3866 kVA. The generator set shall be capable of recovering to a minimum of 90 percent of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set.

5. The alternator shall produce a clean AC voltage waveform, with not more than 5 percent total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3 percent in any single harmonic, and no third order harmonics or their multiples. Telephone influence factor shall be less than 40.

6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the Drawings.

2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel if walk-in enclosure.

3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.3 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, EPA Tier 2 certified, 4-cycle, radiator and fan cooled. Minimum displacement shall be 1860 cubic inches, with twelve cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two-cycle engines are not acceptable.

B. A digital electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function

of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.

C. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H_2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/ fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental Electric starter(s) capable of three complete cranking cycles without overheating.

2.4 ENGINE ACCESSORY EQUIPMENT

A. The engine for the generator shall include the following accessories:

1. Positive displacement, contact.

2. Mechanical, full pressure, lubrication oil pump.

3. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

4. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

5. Replaceable dry element air cleaner with restriction indicator.

6. Flexible supply and return fuel lines.

7. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

B. Coolant Heater

1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.

2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall provisions to isolate the heater for replacement of the

heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

3. The coolant heater shall be provided with a 24 VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

4. The coolant heater(s) shall be 120V, 1500 watts and sized as recommended by the engine manufacturer to warm the engine to a minimum of 104 degrees F (40 degrees C) in a 40 degrees F (4 degrees C) ambient, in compliance with NFPA 110 requirements, or the temperature required for starting and load pickup requirements of this specification.

C. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

D. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40 degrees F ambient temperature when fully charged.

E. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed inside the sound enclosure.

F. A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. The charger shall be wall mounted inside sound enclosure and factory wired to the 100 amp load center. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:

1. Loss of AC Power - red light.
2. Low Battery Voltage - red light.
3. High Battery Voltage - red light.
4. Power ON - green light (no relay contact).

G. Charger shall include an analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses.

2.5 AC ALTERNATOR

A. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 80 degrees C.

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300 percent of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 10.2 percent, based on the 80°C rise rating.

E. Alternator shall be rated for a minimum of 828 kW at a 80°C, standby.

2.6 ENGINE GENERATOR SET CONTROL

A. Generator set Control - The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

B. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

C. Control Switches

1. Mode Select Switch - The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position, the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate pushbutton to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

2. EMERGENCY STOP Switch - Switch shall be red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

3. RESET Switch - The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

4. PANEL LAMP Switch - Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

D. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

1. Digital metering set, .5 percent accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral

voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.

2. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1 percent at rated output. Both analog and digital metering are required.

3. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments. The control shall display hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.

V. The control system shall log total number of operating hours, total kWH, and total control on hours, as well as total values since reset.

Generator Set Alarm and Status Display

1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:

   a. The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).

   b. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.

   c. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.

   d. The control shall include an amber common warning indication lamp.

2. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:

   - Low oil pressure (warning)
   - Low oil pressure (shutdown)
   - Oil pressure sender failure (warning)
   - Low coolant temperature (warning)
   - High coolant temperature (warning)

- High coolant temperature (shutdown)
- High oil temperature (warning)
- Engine temperature sender failure (warning)
- Low coolant level (warning)
- Fail to crank (shutdown)
- Fail to start/overcrank (shutdown)
- Overspeed (shutdown)
- Low DC voltage (warning)
- High DC voltage (warning)
- Weak battery (warning)
- High AC voltage (shutdown)
- Low AC voltage (shutdown)
- Underfrequency (shutdown)
- Overcurrent (warning)
- Overcurrent (shutdown)
- Short circuit (shutdown)
- Ground fault (warning)
- Overload (warning)
- Emergency stop (shutdown)
- Four configurable conditions

3. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

E. Engine Status Monitoring

1. The following information shall be available from a digital status panel on the generator set control:

- Engine oil pressure (psi or kPA)
- Engine coolant temperature (degrees F or C)
- Engine oil temperature (degrees F or C)
- Engine speed (rpm)
- Number of hours of operation (hours)
- Number of start attempts
- Battery voltage (DC volts)

2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

3. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the Drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for Level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions

shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA 110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.

The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

CONDITION	LAMP COLOR	AUDIBLE ALARM
Genset Supplying Load	Amber	No
Charger AC Failure	Amber	Yes
Low Coolant Level	Amber	Yes
Low Fuel Level	Red	Yes
Check Genset	Amber	No
Not In Auto	Red	Yes
Genset Running	Amber	No
High Battery Voltage	Amber	Yes
Low Battery Voltage	Red	Yes
Weak Battery	Red	Yes
Fail to Start	Red	Yes
Low Coolant Temperature	Red	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Red	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Four spares	Configurable	Configurable

2.7 ENGINE CONTROL FUNCTIONS

A. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.

B. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled. Total duration of operating time in the idle mode shall be controlled by the system, to prevent degradation of the engine capabilities due to excess operating time at idle.

C. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.

D. The control system shall include time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.

E. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

2.8 ALTERNATOR CONTROL FUNCTIONS

A. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

B. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110 percent of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

C. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70 Article 445.

D. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

E. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110 percent of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130 percent. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85 percent for more than 10 seconds.

F. When required by National Electrical Code or indicated on project drawings, the control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

2.9 OTHER CONTROL FUNCTIONS

A. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

2.10 GENERATOR MAIN LINE CIRCUIT BREAKER

A. The generator set shall be provided with a mounted main line circuit breaker, rated 1,200 amps. The circuit breakers shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

2.11 OUTDOOR WEATHER-PROTECTIVE SOUND ATTENUATED ENCLOSURE

A. Construction

1. Steel - UL 2200 listed sound attenuated, weatherproof genset enclosure. Package shall comply with the requirements of the NEC for all wiring materials and components.

2. Sound attenuation rating of 73.8 dBA @ 7m.

3. The enclosure shall be designed in which allows generator set to operate at full rated load in an ambient temperature of up to 122 degrees F.

B. The enclosure will consist of a cambered roof, two sidewalls, two end walls, incorporating prepainted steel construction and application-specific non-hydroscopic acoustic insulation, air handling equipment designed to provide the specified level of sound attenuation.

C. Exhaust silencer shall be installed inside enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with rain cap.

D. The enclosure shall include flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure with internal drain valves.

E. External radiator fill provision must be provided.

F. Doors shall be recessed, lockable with retainers to hold doors open for easy access.

G. Inlet of enclosure shall be provided with rodent barriers.

H. Enclosure shall be wind load rated 150 MPH.

I. Motorized intake louvers, contact open on fail, motor closed. Wired to load center as described on paragraph J below.

J. 50-amp, 120/208V, 1Ø, 3 wire load center pre-wired to jacket water heater, battery charger, intake louver, and all pertinent accessories.

PART 3- EXECUTION

3.1 ACCEPTANCE

A. Equipment shall be initially started and operated by representatives of the manufacturer.

B. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than two, four-hour sessions in duration and the class size shall be limited to five persons. Training date shall be coordinated with the facility owner.

3.3 DEMONSTRATION

A. Provide systems demonstration. Electrical Contractor shall provide fuel for testing and shall fill tank complete after all testing is done and before turning over to Owner.

B. Describe loads connected to standby system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide standby power.

END OF SECTION 26 32 16

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SECTION 26 36 00

TRANSFER SWITCHES

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Section 260553 - Identification for Electrical Systems: Engraved nameplates.

B. Section 263213 - Package Engine-Generator Systems – Diesel Indoors: Testing requirements.

C. Section 16010 - Operations and Maintenance manuals.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NEMA ICS 1 - General Standards for Industrial Control and Systems.

C. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.

D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum twenty (20) years documented experience and with service facilities within one hundred (100) miles of Project.

B. Supplier: Authorized distributor of specified manufacturer with minimum ten (10) years documented experience. Authorized distributor and service provider shall be within 50 miles of the project site and no more than one (1) adjacent state from the project site. Supply of the equipment, startup, testing, demonstration and training shall be provided by the local authorized distributor.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

1.5 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of transfer switch for one (1) year from Date of Substantial Completion.

1.7 MAINTENANCE MATERIALS

A. Provide two (2) of each special tool required for maintenance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ASCO, Model 4000 Series 4ATS

2.2 AUTOMATIC TRANSFER SWITCH

A. Description: NEMA ICS 10, automatic transfer switch.

B. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices will not be accepted.

C. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

D. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

E. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand current capability and be protected by separate arcing contacts.

F. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

G. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

H. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.3 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS.

B. Temperature: 105 degrees F

C. Altitude: 1000 feet

2.4 RATINGS

A. Voltage: 480/277 volts, three phase, four wire, 60 Hz

B. Switched Poles: 3

C. Load Inrush Rating: Combination load.

D. Continuous Rating: As indicated on drawings.

E. Interrupting Capacity: 100 percent of continuous rating.

F. Withstand Current Rating: The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.

2.5 PRODUCT OPTIONS AND FEATURES TO BE PROVIDED

A. Indicating led (light emitting diode) lights: Mount in cover of enclosure, one to indicate when the ATS is connected to normal source (green), one to indicate when the ATS is connected to emergency source (red), one to indicate when the normal source is available (green) and one to indicate when the emergency source is available (red).

B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.

C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source, to bypass time delay.

D. Transfer Switch Auxiliary contacts: Contacts rated 10 amps, 480VAC shall be provided consisting of one contact, closed when the ATS is connected to normal source and one contact closed, when the ATS is connected to emergency source.

E. Normal Source Monitor: The voltage of each phase of the normal source shall be monitored, with pickup adjustable from 85% to 100% and dropout adjustable from 75% to 98% of pickup setting.

F. Alternate Source Monitor: Single-phase voltage sensing of the emergency source shall be provided, with a pickup voltage adjustable from 85% to 100% and frequency sensing with pickup adjustable from 90% to 100%.

G. In-Phase Monitor.

H. Solid Neutral.

2.6 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay To Start Alternate Source Engine Generator: 0 to 6 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 5 minutes adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 60 minutes, adjustable, of unloaded operation.

H. Repetitive accuracy of all settings shall be +/- 2% or better over an operating temperature range of -20°C to 70°C. Voltage and frequency settings shall be fully field adjustable in 1% increments over the whole range without the use of tools, meters or power supplies.

2.7 ENCLOSURE

A. Enclosure: ICS 6, NEMA Type 1 at Sanford Street; NEMA 3RX secure double door (304 stainless steel) at Old Borne.

B. Finish: Manufacturer's standard gray enamel.

PART 3EXECUTION

3.1 EXAMINATION

A. Verify that surface is suitable for transfer switch installation.

3.2 INSTALLATION

A. Install transfer switches in accordance with manufacturer's instructions.

B. Provide engraved plastic nameplates under the provisions of Section 16195.

3.3 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems.

3.4 DEMONSTRATION

A. Demonstrate operation of transfer switch normal and emergency modes.

3.5 TESTS AND CERTIFICATION

A. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

B. The manufacturer shall be certified to the ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

3.6 SERVICE REPRESENTATION

A. The ATS manufacturer shall maintain a local service center within a 100 mile radius of the job location. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of twenty (20) years.

END OF SECTION 26 36 00

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SECTION 26 51 19

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of LED luminaires:

1. Materials.
2. Finishes.
3. Luminaire support.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, arranged by designation.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved:

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

C. Product Certificates: For each type of luminaire.

D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 10.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. Standards:
1. UL Listing: Listed for damp location.
2. Recessed luminaires shall comply with NEMA LE 4.

D. CRI of minimum 80.

E. Internal driver.

F. Nominal Operating Voltage: 120v or 277 V ac.

1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

2.3 LUMINAIRE TYPES

A. Refer to lighting fixture schedule on drawings for fixture types.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers, and Globes:

1. prismatic acrylic
2. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. As indicated on drawings.

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install required ballasts, drivers, & lamps in lighting fixtures of wattages, quantities, and types specified as shown on the drawings and as indicated in the lighting fixture schedule.

D. Supports: Sized and rated for luminaire weight.

E. Flush-Mounted Luminaire Support: Secured to outlet box.

F. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

G. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Replace all defective parts prior to turn over of equipment.

END OF SECTION 26 51 19

SECTION 26 56 26

SITE LIGHTING

PART 1 – GENERAL

1.1 SUMMARY

A. The work intended under this section includes furnishing and installation of the site lighting including all wiring, materials, equipment and labor their related items necessary to complete the installation of the electrical system as shown on, or as may reasonably be inferred from the drawings and as described in the specification. Such work shall include but is not necessarily limited to the following:

1. Accent Light

1.2 STANDARDS FOR WORK PERFORMED

A. The electrical materials, construction and installation shall conform to S.S.S. 906 and the requirements of the National Electrical Code of the National Fire Protection Association (Latest Editions), and shall conform to all local and special laws or ordinances governing such installation, and to the special requirements herein set forth. The contractor shall supply the required underwriter's certificate for all work performed.

B. Materials and equipment shall be essentially the standard catalog products of a manufacturer regularly engaged in the manufacture of the products. Materials and equipment shall meet the applicable requirements of these specifications, and shall essentially duplicate material and equipment that have been in satisfactory use at least two years.

C. The contractor shall be specifically responsible for the coordination and proper relation of the work to the site and to the work of all trades. The contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the owner of any discrepancy before performing any work.

D. All materials and workmanship shall be of a high quality generally accepted as standard practices and procedures by the electrical industry for commercial work.

E. Whenever drawings or specifications require materials, workmanship, arrangement or construction of higher standard or larger size than is required by codes and regulations, drawings and specifications shall take precedence.

F. Should there be direct conflict between above mentioned regulations and drawings or specifications, the regulations shall govern. Contractor shall install all equipment in accordance with the governing regulations without additional cost to the owner.

G. All electrical materials and equipment shall bear label of underwriter's laboratories, be listed by them in their list of electrical equipment, and be approved by them for purpose they are used, unless material and equipment are of type for which underwriter's laboratories do not list or provide label

service.

1.3 SUBMITTALS

A. Shop drawings, manufacturer's data, or cut sheets, shall be provided

1.4 PRODUCT HANDLING

A. Protection: use all means necessary to protect the material of this section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: in the event of damage, immediately make all repairs and replacements necessary to the approval of the landscape architect, and at no additional cost.

1.5 COORDINATION

A. All work must be in conformance with the appropriate jurisdictional authority and in conformance with any permits issued for this project.

B. Surface conditions: prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is completed to the point where this installation may properly commence.

C. Discrepancies: in the event of discrepancy, immediately notify the Landscape Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

D. Contractor shall coordinate with other trades working on building electrical work, site planter walls, seating and pavements.

PART 2 - PRODUCTS

2.1 LIGHTING

A. All lighting fixtures shall be provided and installed in compliance with all government agencies having jurisdiction and in strict accordance with all applicable provisions of the building and electrical code of the City of Newark. Installation of all lighting fixtures shall be performed in strict compliance with all applicable provisions of the National Electric Code. All fixtures shall bear the appropriate UL (or ETL) and IBEW identifications.

B. Materials and equipment, as well as workmanship, shall conform to the highest commercial standards and shall be as specified and/or as indicated on the drawings. Parts not specifically identified shall be made of materials most appropriate for their intended use.

C. Provide the sizes, types and ratings indicated complete with housings, lenses refractors, lamps, lamp holders, reflectors, ballasts, starters, igniters, mounting brackets or hardware with adjusting means and wiring.

D. Manufacture
   1. Accent light shall be Model #2205-LED as manufactured by Vista Professional Outdoor Lighting, 1625 Surveyor Ave., Simi Valley, CA 93063, or approved equal.

E. Furnish and install lighting fixtures as noted on the drawings. Fixtures shall be completely wired and lamps installed and shall be in perfect operating condition at the time of completion.

F. Lighting fixtures shall be of rigid construction, dimensionally stable, and shall be assembled with secure fastenings. Ferrous parts shall be protected from corrosion by painting or other approved means.

G. Light shall be free from defects or blemishes. Any damage to paint during delivery or installation shall be repaired by the contractor as per manufacturer's recommendations, at no expense to the owner.

H. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and be effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final written acceptance of the work by the owner. Contractor shall submit shop drawings and catalog cuts for approval prior to installation.

I. Polyester powder-coat finish, color shall be Black.

PART 3 - EXECUTION

3.1 SITE LIGHTING

A. If the contractor finds any discrepancy they are responsible for notifying the Landscape Architect, Engineer and Owner prior to construction.

B. Install pedestrian lights and solar bollards as shown on the plans.

C. Steel access panels shall be cut to proper size at the shop and installed on site in accordance with approved shop drawings.

D. Apply zinc paint coating over welded areas of galvanized steel and over areas of previously galvanized members on which the galvanizing has become damaged. Before applying the compound, ensure the welded or damaged area is clean and free of grease. Thoroughly brush area with stiff wire brush and grease-removing solvent. Apply two coats.

E. Grounding: provide equipment bonding and grounding connections, sufficiently tight to assure permanent and effective grounds, where indicated, for installed poles and standards. Bond all metal, noncurrent carrying parts to ground.

END OF SECTION 26 56 29

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SPECIFICATIONS GROUP

Facility Services Subgroup

DIVISION 27- COMMUNICATIONS

27 15 13 COMMUNICATIONS COPPER HORIZONTAL CABLING

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SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, Division 27 Specification Sections, apply to this Section

1.2 GENERAL

A. The intent of this project will be to replace the existing copper CAT 6 communications infrastructure with CAT 6A and eliminate/remove some of the existing data drops as indicated on the drawings. Existing conduit and back boxes shall be reused wherever possible and with new data receptacles provided. All existing CAT 6 cables shall be removed and abandoned data receptacles shall be provided with blank cover plates to match existing or new (to be coordinated with Owner).

B. All components shall be guaranteed by the manufacturers to operate to the TIA/EIA Category 6A standard when installed. The complete channel shall conform to this standard where the channel is defined as all cabling, patch panels, and jacks.

C. The Owner shall be provided with a minimum 25year Application Assurance Warranty covering the cost of all material and labor. The warranty will guarantee the following and other applications: 10 BASE – T, 100 BASE – T, 1000 BASE-T, 1000 BASE-TX, 155 MBPS ATM, 16 MBPS Token Ring. The Technology Contractor must be certified by the cable plant manufacturer for a minimum of 60 days prior to submission of the bid and must have installed at least six (6) similar systems by the proposed connectivity manufacturer.

D. The data cabling inside the building is to be TIA/EIA 568 Category 6A cable. All connecting hardware, including patch panel connectors and patch cords, shall provide performance as specified in the TIA/EIA 568 Category 6A standard. All cables shall be plenum rated and color jacketed as noted on the plans (Data- Yellow, Voice-Green, CCTV- Blue & WiFi- Orange). All Category 6A connecting hardware shall be manufactured by the same manufacturer.

E. All the components shall be approved components per the cabling system manufacturer, so that the required warranty can be provided by the specified manufacturers.

F. Provide Category 6A rated four (4) pair cabling to each Data, Voice, WiFi, CCTV and Fax locations as shown on the drawings.

G. Horizontal Cabling Description
1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.(no splices or connections of smaller cables)
3. Bridged taps and splices shall not be installed in the horizontal cabling.

5. A work area includes the components that extend from the telecommunications outlet/connectors to the station equipment.
6. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) in the horizontal cross-connect.

PART 2 – PRODUCTS

2.1 CATEGORY 6A Cable

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. Commscope Systimax
4. Or Approved Equal

B. The premise wiring shall consist of 4 pairs of shielded twisted pairs, overall jacket colored as follows:
1. Data – Yellow
2. Voice – Green
3. CCTV- Blue
4. WiFi - Orange

C. The cabling shall operate in accordance with the Category 6A TIA/EIA standard

D. The conductor shall be 23 AWG solid bare copper.

E. The cable shall have plenum insulation with ripcord. Outdoor cable shall bear the label of Outdoor Plant rating.

F. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

G. Comply with ICEA S-90-661 for mechanical properties.

H. Comply with TIA/EIA-568-B.1 for performance specifications.

I. Comply with TIA/EIA-568-B.2, Category 6A.

J. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

K. The cable shall be tested for and exhibit the following characteristics, at minimum performance.

Freq. (MHz)	Maximum Attenuation DB/100 m (328 ft.)	Near End Cross Talk (NEXT)	Structural Return Loss (SRL) Minimum dB
0.772	1.8	67.0	-19.4 dB

1.0	2.0	65.3	-20.0 dB
4.0	4.1	56.3	-23.0 dB
8.0	5.8	51.8	-24.5 dB
10.0	6.5	50.3	-25.0 dB
16.0	8.2	47.2	-25.0 dB
20.0	9.3	45.8	-25.0 dB
25.0	10.4	44.3	-24.3 dB
62.5	17.0	38.4	-21.5 dB
100	22.0	35.3	-20.1 dB

L. Provide pre-manufactured Cat 6A patch cables and crossover cable where required for connections from patch panels to network switches.

2.2 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Patch panels shall be 24 or 48 port panels. Provide quantity as required plus spares and blank positions adequate to suit specified expansion criteria.
2. Provide clear plastic cover to protect the circuit board.
3. Patch panels shall be equipped with rear cable management bar.
4. Patch panels shall be provided within the Telecommunication Rooms for the termination of category 6A cabling. Patch cables shall have the same jacket color as the system they support, yellow for Data, green for Voice, purple for Fax, Blue for CCTV and orange for WiFi. They Ashall terminate on owner's switch and be interconnected via the patch panel(s) to the Category 6 horizontal distribution cables.
5. Patch panel shall exceed TIA/EIA B.2-1 and IEC 60603-7-4 for component performance.
6. Terminate 4 pair category 6A cables on 110 style connection wired per TIA/EIA 568B wiring.
7. Provide icons on patch panels as well as labels for easy identification.
8. Manufacturers: Hubbell, Belden, Leviton or approved equal.

C Cat 6A Connectors:

1. Manufacturers:

   A. Leviton
   B. Belden
   C. Or Equal.

2. Color: Cat 6A Connector colors shall match cable color according to designated use.
   a. Data- Yellow (Leviton Model No. 61110-RY6)
   b. Voice-Green (Leviton Model No. 61110-RV6)
   c. WiFi- Orange (Leviton Model No. 61110-RY6)
   d. CCTV- Blue (Leviton Model No. 61110-BL6)

D. Wall Plates:

1. Manufacturers:

   A. Leviton
   B. Or Equal.

2. Type: Single Gang, ID window, flush mount wall plates with 1, 2, 3 or 4 ports. (Leviton Model No. 42080-1WS/2WS/3WS/4WS)

3. Color: White only.

E. Surface Mount Back Boxes

1. Manufacturers:

   A. Leviton
   B. Or Equal.

2. Type: Single Gang, compatible with wall plates and connectors. Install on block or cement walls, or where indicated on drawings, using surface metal raceway or conduit for bottom entry. Anchor to wall.

3. Color: White only.

F. Mounting Plate Brackets

4. Manufacturers:

   C. Caddy (Erico)
   D. Or Equal.

5. Type: Metallic, screw on. For use with drywall only. Positive support with locking screws.

6. Color: White only.

PART 3 – EXECUTION

3.1 SYSTEM INSTALLATION

A. All these devices shall be installed in strict conformity with the structured cabling system manufacturer's requirements and TIA/EIA 568 standards.

B. The wiring shall be installed with adequate slack in all pull boxes. There should be a service loop of no less than 5 feet in the floor closet.

C. The wiring shall be neatly dressed and bundled on one side of the mounting board or the rack.

D. All cables shall be tested prior to being put in service. Provide written test report.

3.2 PRICE LIST – to be used for adding or deleting work, not to be included in base bid –

Item 1 - Installation of a single recessed network drop installed in a above ceiling and hollow wall construction as described in the contract documents, including but not limited to (1) Cat 6A

jack, single port wall plate, Cat 6A Cable (100 LF cable), labeling, testing, termination, etc.
COST $_____

Item 2 - Installation of a single surface mount network drop installed from the floor below as described in the contract documents, including but not limited to (1) Cat 6A jack, single port wall plate, Cat 6A Cable (100 LF cable), labeling, testing, and penetration through slab floor construction etc. COST $_____

Item 3 – 100 LF Cat 6A Cable above ceiling COST $_____

END OF SECTION 27 15 13

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SPECIFICATIONS GROUP

Facility Services Subgroup

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

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Video Security

Master Project Specifications

March 4th, 2021

Ver. 1.1

SECTION 28 00 00 – ELECTRONIC SAFETY AND SECURITY

SECTION 28 23 13 – VIDEO SURVEILLANCE CONTROL AND MANAGEMENT SYSTEMS

28 23 29 – VIDEO SURVEILLANCE REMOTE DEVICES AND SENSORS

SECTION 28 00 00 – ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Division 1 Specifications
B. Security Drawings
C. Camera and Device Matrices

1.2. SUMMARY

A. These plans and specifications and all related documents are complimentary meaning that whatever is defined on any document is just as binding as if defined on all documents.

B. This specification applies to new installations of video surveillance technologies which will be contemporary high definition (HD) IP cameras and the Colleges software platform - Genetec Security Center Enterprise Edition. Point to point secured wireless links shall be considered for remote exterior cameras where applicable.

C. Refer to the applicable Project Security Drawings for all camera locations and IDF room locations.

D. Quotes shall be turnkey (except where noted) to include all parts, labor, cabling, software, programming, and training.

E. The Security Control room is located in the Campus Police Building on Lincoln Ave.

F. VMS server, storage, and client PC's to be provided by others unless otherwise specified.

G. Local 120VAC, network infrastructure, cable trays, etc. to be provided by others unless otherwise specified.

H. IDF network infrastructure and 120VAC power shall be provided by others.

I. Conduct training for all provided systems.

1.3. TERMS AND DEFINTIONS

A. Approved Equal: Material, equipment, or method proposed by the contractor that has been properly submitted and approved by the Owner to be substituted for a required item if it is equal in quality, performance and other characteristics. The Contractor bears the responsibility to provide all supporting documentation to demonstrate that their proposed solution is equal.

B. Contractor: Security Systems Contractor

C. CCTV: Closed-circuit television. A term for analog video systems that predate contemporary digital IP video systems.

D. CIF: Common Intermediate Format, A unit of measurement typically used in older "standard definition" CCTV systems to define picture resolution.

E. CPU: Central Processing Unit. The primary circuitry that carries out the basic arithmetical, logical and I/O functions in a computer or computerized appliance.

F. Credential: Data assigned to an entity and used to identify that entity, e.g. user name and password needed to log into and operate the VMS software.

G. DCM: Door Control Module that provides card reader connection(s) and I/O logic for a card reader controlled door. The DCM may be integrated into the ACM or a separate PC board attached through a data bus, typically RS-485.

H. DVD: Digital Video Disc.

I. H.264: A highly efficient video compression technology.

J. High Definition (HD): Contemporary video and broadcast standards providing picture resolution that is substantially higher than standard NTSC/PAL definition, e.g. 1080p or higher.

K. IDS: Intrusion Detection System.

L. I/O: Input/Output. Communications between electrical and electronic components and devices,

M. IP Address: (Internet Protocol) a numeric label assigned to each device participating in a network, e.g 192.168.1.1

N. IPS: Images Per Second (or FPS, Frames per Second), the frequency of consecutive image updates per second used for motion video. Higher IPS results in more fluid, less “choppy” video.

O. LAN: Local area network. Typically a network that is confined to a single facility.

P. LED: Light Emitting Diode, Contemporary technology use for computer monitors and large format displays.

Q. MPEG: Moving Pictures Experts Group is group of recognized subject matter authorities that set standards for video and audio compression technologies.

R. NVR: Network Video Recorder, typically a server grade computer with built-in Raid-5 hard drive storage to store archived video.

S. O/S: Computer Operating System, i.e. Windows 10, Server 2016, Linux.

T. PC: Personal Computer. Generic term for a laptop or desktop computer.

U. RAID-5: (or RAID-6) fault-tolerant computer hard drive storage configuration.

V. RAM: Random Access Memory, standard PC and server internal memory.

W. REX: Request to Exit. A signal sent to the SMS to indicate a valid exit through a door. A door opened after a valid Rex signal is received does not generate an alarm in the system.

X. Server: Dedicated “high-end” computer that runs the VMS head-end software, and is often equipped with large amounts of hard drive capacity for video archiving.

Y. SMS: Security Management System also referred to as the Access Control and Alarm Monitoring (ACAM) System.

Z. SSA: Software Service Agreement

AA. UL Laboratories: An independent, not-for-profit product safety testing and certification organization.

BB. UPS: Uninterruptible power supply used to maintain computer equipment, usually through short term power disruptions, or during the interim until emergency generator takes over in the event of extended power outages.

CC. WAN: Wide area network. Typically multiple Local Area Networks (LAN) connected over long spans utilizing disparate transmission technologies and subscriber services

DD. VMS: Video Management System, software that manages camera video, storage, archived video search and retrieval, users, client seats, etc.

1.4. INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.
B. As a NY State entity, Purchase College SUNY is a self-permitting agency.

1.5. BID SUBMITTALS

A. Contractor shall carefully review the project drawings and specifications and immediately report any possible omissions or conflicts.

B. Contactor shall provide a narrative of their understanding of the scope, schedule, ability and resources to be provided to complete the work, and an acknowledgement that their solution is in full compliance with these plans and specifications, and/or a brief description of equals being offered.

C. Bid submittal shall identify all subcontractors and a brief description of the services they will be providing.

D. Provide qualifying documentation required per the General Division 1 and these specifications, such as proof of insurance, certifications, references, and any other required documentation.

E. Provide a complete Bill of Materials (BoM) per section that details quantities for each part, part number, and description.

F. Provide line-item pricing for each item shown on the “Neuberger-Bid-Estimators-Workbook.xlsx”

G. Provide pricing per section to include costs broken down by materials and labor.

H. Complete the “Camera-Card-Bid-Estimators-Workbook.xlsx” to provide a clear and concise pricing worksheet that summarizes the pricing of all sections and then a grand total for the entire project. If voluntary alternatives are provided, the add/deduct pricing shall be detailed separately.

I. Product Data: Submit manufacturer's data on equipment and materials, and shop drawings, as listed below. Clearly indicate proposed substitutions and deviations from drawings and specifications. Approval of product data and shop drawings is not to be interpreted as permitting departure from the contract documents.

J. Submission

1. Electronic copies of all bid submittal materials shall be provided on memory stick or similar medium. All files must be clearly organized and clearly named.
2. Submit bid response documents in a single binder with tabs and a title sheet separating each section. Do NOT submit data in separate binders. Data submitted separately will be rejected without comment.

K. SECTIONS:

28 23 13 - Video Surveillance Control and Management Systems
28 23 29 – Video Surveillance Remote Devices and Sensors

1.6. WARRANTY

A. All parts and labor shall be warrantied against defect in product and workmanship for a period of 1 year from substantial completion.

B. All manufacturer warranties on parts beyond the initial 1 year warranty period shall be honored throughout the duration of the factory warranty.

C. Warranty services shall cover installation and parts and software failures that occur as a result of normal use and wear and tear. Accidental and vandalism damage to equipment is not covered, nor are acts of God such as earthquakes, lightning, hurricane winds, tornados, floods, etc.

1.7. SHOP DRAWINGS

A. If specified, provide a full set of shop drawings to include installation and mounting details, wiring requirements, Equipment inventory for each panel and IDF room, power and data requirements, etc.

1.8. CLOSEOUT DOCUMENTATION

A. Operating and Maintenance Manuals: Provide three sets of the following documentation in hard copy plus electronic format. Arrange each hard copy in an orderly way, and bind each set in a separate 3-ring, hard-cover binder to be provided within 30 Days of system acceptance:

1. Operating and maintenance instructions.
2. Copies of approved submittal data.

B. Record Drawings (as-builts). Provide Mark-up on as-built drawings (Visio) software utilizing Owner-provided backgrounds and other design drawings to show installed locations for all devices. Deliver as-builts (2 copies) in 11”x17” (min) hardcopy and as electronic files in .dwg/.vsd and PDF.

C. Spreadsheet listing all installed devices, servers, computers, etc. to include labeling nomenclature of device, model, location, IP address, encoder and port, cable type, power source, and comments. Provide both hard copy and electronically in Microsoft Excel format.

D. All electronic closeout documents shall be unlocked and editable by the Owner.

1.9. QUALITY ASSURANCE

A. Electrical and electronic Components, Devices, and Accessories: UL Listed and labeled and marked for intended use.

B. Comply with applicable requirements of recognized industry associations which promulgate standards for the various trades.

C. Assign only qualified technicians who are trained and certified on the products and work to be provided under this Contract. Employ a competent project manager to oversee and supervise the work.

1. Installation technicians must be certified in Genetec Security Center Enterprise Edition 5.9 or higher.

D. Perform work specified in Division 28 in accordance with standards listed below including amendments or revisions. In case of conflict, obtain a decision from the Owner's Representative:

1. International Building Code
2. Any other applicable state and local codes or industry accepted standard practices.

E. Contractor will comply with all on-site construction requirements to include any necessary safety training, Occupational Safety and Health Administration Standards, all National Consensus Standards, and all other federal, state and local safety codes and regulations, and all other safety and personal conduct policies as required by SUNY Purchase College and the onsite General Contractor.

1.9. DISCLOSURE OF NONCONFORMING EQUIPMENT

A. Purchase College desires to make an informed decision regarding the Contractor's proposed project approach.

B. The Contractor is required to disclose, separate from any cut or advertising sheets, any functional, operational or electrical requirements of these specifications that they are not able to perform and/or which fall outside the scope of their quotation.

C. The form of this disclosure shall be by letter clearly identifying these noncompliant items and describing how the Contractor intends to address these issues.

D. Absent such disclosure and subsequent acceptance of non-compliant items by the Owner, Contractors are responsible for ensuring that their systems will fully operate as outlined in these specifications without additional cost to the Owner or other parties.

E. The Contractor may elect to provide an alternate design approach if cost savings or increased functionality could be realized. This approach must be clearly outlined, priced, and tabbed separately within their bid submittal, and fully meet or exceed the objectives of the Basis of Design.

1.10. COORDINATION

A. Carefully examine specifications and drawings to be thoroughly familiar with items which require electrical connections and coordination and to the attention of the Owner or Owner’s Representative any apparent conflicts, omissions or discrepancies.

B. Coordinate with other trades as required for network connectivity, cabling, pathways, 120VAC power receptacles, access panels, and mounting surfaces.

C. Coordinate with the Owner regarding IP address schema, VLAN, etc.

D. Coordinate work schedule and equipment deliveries with the Owner and General Contractor.

1.11. DELIVERY AND STORAGE

A. Deliver items in manufacturer's original unopened packaging. Use care in loading, transporting, unloading, and storage to keep items from being damaged. Contractor is responsible to store and safeguard all supplied equipment.

B. Equipment shall be stored in environmental conditions suitable for the equipment and per the manufacturer’s instructions.

1.12. RECORD DRAWINGS

A. Keep a set of prints at the job site exclusively for recording deviations from the drawings which are necessary because of field conditions.

B. Mark deviations in colored pens/pencils so that work of various systems can be easily identified.

C. Wire routing and paths shall be annotated in red.

PART 2 - PRODUCTS

2.1. MATERIAL AND EQUIPMENT

A. All materials shall be new and have UL listing when such listing is available.

B. Provide products named in this specification unless an equal product has been approved.

PART 3 - EXECUTION

3.1. EQUIPMENT INSTALLATION

A. Installation of devices shall be in accordance with the manufacturer's instructions, properly secured to the designated mounting surface, all wiring properly terminated and appropriately dressed, and in accordance with accepted industry best practices and workmanship standards.

B. Cameras shall be located appropriately so that they have a clear and unobstructed field of view of the subject matter to be monitored. Contractor shall immediately bring any unforeseen view obstructions such as signage, fixtures, etc. to the attention of the Owner or their Consultant.

C. Field verify all camera views with the Owner or their Consultant prior to commissioning. Clean domes to remove dirt and debris before testing and commissioning. Provide covers as needed to protect acrylic camera domes for scratching and abrasion damage resulting from construction dirt and debris.

D. Equipment shall be kept clean and free of dust. Climate and dust sensitive equipment such as servers and PC workstations shall be installed in the designated location only after the rooms have been cleaned and are environmentally suitable for the equipment.

3.2. SUPPORT INSTALLATION

A. Devices and cameras shall have adequate support appropriate for the weight of the device.

B. Provide grid hangars to support drop-ceiling mounted cameras. Cameras supported by acoustical ceiling tiles alone will not be accepted.

C. Vandal resistant cameras shall be securely mounted to a sufficiently structurally sound wall or ceiling surface with tamper-proof screws.

3.3. CABLE INSTALLATION

A. Category 6 network drops and fiber optic cabling to cameras, servers and workstations will be provided by others. All other cabling to be provided and installed by the Contractor.

B. All installed cabling will be fully protected and utilize appropriate pathways and support.

C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Seal around cables penetrating fire-rated elements in accordance with LS-01 and building code requirements.

G. All cabling will be appropriately marked at each end with permanent machine-printed wire labels.

3.4. CONNECTIONS

A. Conductor Splices: All cabling to be installed end to end with no splices and terminate to a designated patch panel within the assigned Equip Room.

B. Network cable terminations shall be according to TIA/EIA-568 standards. Pair twists shall be maintained to the point of connection and meet all other Division 27 requirements.

C. Patch cables shall be factory terminated and provided at the appropriate length for the application and proper wire management.

3.5. FIRESTOPPING

A. Apply fire-stopping to cable and raceway penetrations of fire-rated floor and wall assemblies to maintain the required fire-resistance rating of the assembly

3.6. CLEANING AND PROTECTION

A. Camera lenses and domes shall be clean and kept free of excessive dirt and dust. All domes and view windows shall be clean before system commissioning and turnover to the Owner.

3.7. TESTS

A. On completion of work, the installation is to be entirely free of ground faults, short circuits, and open circuits. Contractor will work with owner or their consultant to perform testing to include:

1. Perform and document a thorough operational test of all systems.
2. Configure all live view and recording parameters for the system.
3. Verify all fields of view are correct and sharply focused.
4. Test live view and recorded images from all cameras.
5. Perform storage tests to provide accurate video retention estimates.

3.8. ACCEPTANCE TESTING AND COMMISSIONING

A. Contractor to complete and document a comprehensive test of the entire system to ensure that all components are fully function and properly configured.

B. Contractor will provide a detailed test report to the Owner certifying all test results as a pre-condition to begin acceptance testing and commissioning.

C. Successful completion of acceptance testing will begin the system warranty period.

D. Final acceptance testing and commissioning will include but not be limited to the following tests and observations:

1. A physical examination of each camera location to ensure proper installation of newly purchased equipment, wiring and materials.

2. A verification of all video settings and parameters, recording, and playback.

3. Validation of image quality, and field of view to assure camera is properly aimed and focused. Playback of video during nighttime hours to assure cameras are correctly functioning in night mode and that video is usable.

4. Testing of alarm call-up and motion event recording.

5. Verify that video is fully accessible from all required client locations.

6. Verify that fault-tolerant features (RAID 5/6, redundant power supplies, failover, etc.) are functioning correctly.

7. Validate that all recording and other operational parameters defined within these specifications have been met.

8. Inventory of spare parts and any other parts and materials purchased as part of this contract but not installed and turned over to the Owner.

3.9. OWNER FURNISHED EQUIPMENT

A. VMS and Access Control servers, client PC's, network ports.

B. All 120VAC to equipment locations. Connection of 120VAC to equipment to be provided by Contractor.

C. Depending on project scope owner may or may not furnish equipment.

END OF SECTION 28 00 00

SECTION 28 23 13 – VIDEO SURVEILLANCE CONTROL AND MANAGEMENT SYSTEMS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Security Drawings - See "BUILDING Floorplan" for device locations.

1.2. SUMMARY

A. **The VMS shall be an expansion of the existing SUNY Purchase College campus-wide Genetec Security center platform.**

B. This specification defines the Video Management System (VMS) software, computer hardware, network support infrastructure and end point security devices. The VMS platform in use at the college is the Genetec Security Center Enterprise 5.9 edition.

C. VMS software shall be scalable to support an unlimited number of IP cameras, with camera channel licenses to be purchased on an as-needed basis.

D. This section includes video management head-end software, hardware and related accessories.

1. Video Management System (VMS) Server and Client Software.
2. Servers and Storage
3. Client Workstations and viewing monitors

E. All Genetec Security Center software, licensing, and SSA agreements must be purchased through *a licensed Genetec reseller.*

1.3. SUBMITTALS

A. Product Data: Include manufacturer's product datasheets for all components. If multiple models are included on the datasheets then clearly mark the exact product(s) to be provided using either highlighter pen or PDF editing software.

B. Product data sheets shall include dimensions, weight, power consumption, installed components (RAM, Hard Drive capacity, CPU, etc.) and all pertinent operating characteristics.

1.4. DELIVERY, STORAGE AND HANDLING

A. ALL products shall be delivered and stored in accordance to the manufacturer's recommendations and per section 28 23 00 of this Specification.

1.5. WARRANTY AND SERVICE

A. All parts and labor shall be warrantied against defect in product and workmanship for a minimum period of 1 year from substantial completion.

B. All manufacturer warranties on parts beyond the initial 1 year warranty period shall be honored.

C. Provide a Software Service Agreement (SSA) for the Video Management software to include all provided camera channel and other licenses to make them current (co-terminus) with the Purchase College's existing Genetec SSA.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Acceptable Manufacturers or approved equals:

1. Genetec Security Center Systems, Enterprise Edition
2. BCDVideo, Dell Archivers

2.2. VIDEO MANAGEMENT PLATFORM SOFTWARE

A. Video Management Software: Video Management System (VMS) platform will run on non-proprietary storage and hardware, and support a wide variety of 3rd party cameras and encoder hardware.

B. VMS software shall be scalable to support multiple servers, unlimited cameras and users per system, with camera channel licenses to be purchased on an as-needed basis.

C. VMS will support and be provided with the following minimum licensing and feature sets:

1. Provide IP camera channel licenses as needed
2. VMS Client will support multiple monitors and multiple video tile configurations.
3. Multiple user profiles with granular permissions and control settings.
4. Client video down sampling for multi-tiles displays, (resolution and FPS) option.

D. Camera channels will be configured to view and record on a single stream at 1080p resolution or higher, 15FPS, H.264, <30% compression (High quality), with flexible settings for cameras and for days of video retention. The Owner reserves the right to determine the exact parameters for each camera channel based on their needs and requirements.

E. A secondary stream shall be configured for multi-tiled display configurations.

F. The VMS software shall be an extension of the existing Purchase College Genetec Security Center VMS Enterprise Edition platform.

G. Basis of Design is Genetec Security Center Enterprise. **No substitutions.**

2.3. VMS LICENSING

A. Provide VMS IP camera channel licenses and Software Service Agreement (SSA) from the VMS manufacturer to synchronize all cameras with the existing Purchase College Genetec SSA agreement.

2.4. CAMERA STORAGE BUDGET CALCULATIONS

A. Bid response must include a completed copy of the Bandwidth Storage calculation workbook using the template "Bandwidth-Storage-Calculation-Workbook.xlsx" - an example is shown below. Storage and bandwidth calculations must be shown for each camera. If additional columns or commentary are provided, please add them to the right of the columns shown in the example.

Bandwidth and storage calculations must be provided for all cameras meeting the requirements in Section 5, and bandwidth/storage calculations must us the following criteria

1. 3 mp resolution
2. 15 frames per second
3. Continuous recording
4. 24-hour use

	Bandwidth and Storage Calculation Workbook (Sample)						
Camera Type	**Motion Triggered**	**Resolution**	**Framerate**	**Monthly Storage (average)**	**Bandwidth (average)**	**Qty**	**Scenario**
Standard Dome - Reception	No	3mp	15	379gb	2.34mbps	1	Reception
Standard Dome - Exits	No	3mp	15	316gb	1.9mbps	1	Exit Door
Standard Dome - Hi Traffic	No	3mp	15	386gb	2.3mbps	1	Hi-Traffic Area
360-degree ceiling mount	No	3mp	15	906gb	5.59mbps	1	360-degree ceiling mount dome
Exterior 180s Courtyards	No	5mp	15	4.67tb	36.9mbps	1	180-degree exterior

2.5. VIDEO SERVER AND STORAGE HARDWARE

A. Database server to be provided by Others - meets the following minimum specifications:

1. Intel Xeon E5 Processor, 4 Cores, 2.6Hgz
2. 16GB RAM
3. OS Drive 250GB SSD
4. Windows 2016 or above
5. Dual Gigabit NIC
6. DVD ROM
7. 3-Year, next business day onsite factory maintenance and warranty included.
8. Recommended server and storage requirements from the Video Management software manufacturer will take precedence wherever they exceed the above stated minimum requirements.
9. Basis of design: BCD or Dell R620 series.

B. Server/Storage: To be provided by others (unless specified in “Scope” section 7.)
Servers/storage will meet the following minimum specifications:

1. Intel Xeon E5 Processor, 4 cores, 2.8Ghz
2. 32GB RAM
3. OS Drive 500GB SSD
4. 32 TB (RAW) Raid 5 SATA or SAS Storage (or separate Network Attached Storage option)
5. 400Mbps video storage throughput capacity
6. Windows 2012 R2, and above
7. Dual Gigabit NIC
8. DVD Recordable ROM
9. 3-Year, next business day onsite factory maintenance and warranty included.
10. Recommended server and storage requirements from the Video Management software manufacturer will take precedence wherever they exceed the above stated minimum requirements.
11. Basis of design: Dell R730xd series, HP DL190 with onboard raid 5/6 video storage.
12. Basis of design: Dell R630 no onboard storage, remote storage option
13. Basis of Design: BCD.
14. REVIEW THIS SECTION

1.2. VIDEO CLIENT WORKSTATION

A. All VMS client workstation computers to be provided by others (unless specified in “Scope” section 7.)

B. Video Client Workstation PC: Intel i7 class CPU, 3.4Ghz, 16GB RAM, Dual-head GPU video card with 4GB dedicated DDR3 RAM, and current version of 64-bit Windows O/S.

C. Local 120VAC receptacles and network drops by others.

D. Basis of Design: Dell Optiplex 9000 series, BCDVideo BCDT01-GW.

1.3. DESKTOP VIDEO MONITORS

A. Desktop monitors to be provide by others (unless specified in “Scope” section 7.)

B. 24” LED 16:9 format, native 1080p resolution desktop display.

C. Basis of Design: Dell, Viewsonic, or equal.

1.4. LARGE FORMAT MONITORS

A. Large format LED displays shall be commercial grade, LED, 50” or larger, rated for 24/7 use.

B. Provide table stand or wall mount hardware with a minimum of 10 degree tilt. Coordinate with Owner for mounting type before installation.

C. Basis of design is the NEC P463, NEC X462S, or equal

1.5. VMS NETWORK SWITCH

A. Network infrastructure to be provided by others except where otherwise stated in this specification.

1.6. EDGE SUPPLEMENTAL NETWORK SWITCH

A. Locations as shown on the project drawings requiring a remote network switch shall be provided with a hardened 5-port self-managed PoE+ network switch to be installed in either an existing camera power supply enclosure or a new enclosure provided by the Security Contractor. Switch will be uplinked to the Purchase LAN utilizing the appropriate media converters.

B. Provide the manufacturer's recommended external power supply and connect to the existing or Owner-provided 120VAC power source.

C. Basis of design is the Cisco Catalyst 2960-L. Acceptable equals by Juniper, Etc.

1.7. COAX TO ETHERNET MEDIA CONVERTER

A. Coax to Ethernet media converters shall support transmission speeds of up to 150Mbps over standard RG-59 coax, and PoE+ up to 2000'.

B. Media converters shall operate on either coax or two-wire, support multi-drop and daisy chaining topologies for both data and PoE.

C. Media converters shall be available in 1, 2, 4, 8, and 16 port models. Multi-port models shall be rack mounted and have a single 10/100/1000 Base-T port for connection to the LAN and configurable via a web browser.

D. Provide manufacturer's recommended power supplies as needed for all media converter links. Power supplies shall be installed in the Security Room racks and transmit power up the coax to the edge media converter and the camera being served. Multi-port media converters shall be equipped with power supplies sufficient to power all available ports at 15W PoE.

E. Media converters that offer 60W PoE++ (HPoE) may optionally be used to provide power and data over existing coax to exterior PTZ cameras provided that cable length is within the manufacturer's allowable limits and the camera model supports it. It is the responsibility of the Contractor to verify camera compatibility and cable length to assure a fully functional system.

F. Basis of design is the NVT 1800 series transmission products.

PART 2 - EXECUTION

3.1. SERVER INSTALLATION

A. VMS Servers and storage to be provided by others (unless specified in "Scope" section 7.)

B. Insure that all installed software and operating updates and patches are applied.

C. Fully configure the server, OS, and VMS software for proper operation.

3.2. VMS SOFTWARE INSTALLATION

A. If specified in Scope Section 7, installation of VMS software onto the server and client workstations to be performed only by a trained technician who is Genetec certified. VMS server software installation may optionally be installed and pre-configured prior to delivery by an authorized VMS server reseller.

B. All Genetec Security Center software, licensing, and SSA agreements must be purchased through *a licensed Genetec reseller.*

C. Work with the owner to program and configure the VMS system or components to ensure they are fully functional and operational per the requirements of this specification and the recommended best practices as established by the VMS manufacturer.

D. Work with the owner to configure all users, cameras, features, recording, and other tasks as required to deliver a fully configures and operational system.

3.3. VMS CLIENT WORKSTATION SOFTWARE INSTALLATION

A. Client PC computers and monitors to be provided by others (unless specified in “Scope” section 7.)

B. Insure that all installed software and operating updates and patches are applied.

C. Fully configure the, OS, and VMS client software for proper operation.

3.4. TESTS

A. Upon completion of work, the installation is to be entirely free of ground faults, short circuits, and open circuits. Contractor will work with owner or their consultant to perform testing to include:

1. Perform a thorough operational test of all systems.
2. Test all configured user permissions, live view and recording parameters for the system.
3. Verify all cameras are connected, functioning, image quality, and that fields of view are correctly positioned and sharply focused.
4. Verify that the system and connected cameras are correctly configured for operation in a Multicast environment.
5. Test live view and recorded images from all cameras.
6. Verify that image resolution is scaled down in multi-tiled displays to save bandwidth and CPU cycles.
7. Verify functionality of PTZ camera controls and assure that latency is not excessive.
8. Test WDR, low light night camera scenes and adjust cameras for correct focus and noise reduction during night operation.
9. Perform storage tests to provide accurate video retention estimates.
10. Furnish all labor, materials and instrumentation as required for above tests.

B. The VMS software and system components shall run without failure for a period of a least 15 business days before testing and commissioning will be conducted. The “system” shall be defined as the VMS server, software, and cameras, along with any installed cabling infrastructure. If a failure of the system does occur, the clock will be reset once the Owner or their Consultant agree that the issue has been satisfactorily corrected. Failures of Owner-provided equipment and/or cabling that is outside of the Contractor’s control will not reset the clock, but could possibly delay testing and commissioning until the problem is rectified.

3.5. OWNER FURNISHED EQUIPMENT

A. All servers, Storage, and PC client computers.

B. All network connections, network drops to server and PC workstation locations.

C. All 120VAC to existing equipment locations. Connection of 120VAC to equipment to be provided by Contractor.

D. Equipment racks for servers and UPS.

3.6. TRAINING

A. Provide training as specified in the Scope of Work section at the end of this document.

END OF SECTION 28 23 13

28 3 29 – VIDEO SURVEILLANCE REMOTE DEVICES AND SENSORS

PART 4 - GENERAL

4.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 and 26 Specification Sections, apply to this Section.

B. Security Drawings See Building Floorplan

4.2. SUMMARY

4.2.1. This section includes IP cameras and installation.

4.3. SUBMITTALS

4.3.1. Product Data: Include manufacturer's product datasheets for all components. If multiple models are included on the datasheets then clearly mark the exact product(s) to be provided using either highlighter pen or PDF editing software.

4.3.2. Product data sheets shall include dimensions, weight, power consumption, lensing, and all pertinent operating characteristics.

4.4. DELIVERY, STORAGE AND HANDLING

4.4.1. ALL product shall be delivered and stored in accordance to the manufacturer's recommendations and per section 28 23 00 of this Specification.

4.5. WARRANTY AND SERVICE

4.5.1. All parts and labor shall be warrantied against defect in product and workmanship for a period of 1 year from substantial completion.

4.5.2. All manufacturer warranties on parts beyond the initial 1 year warranty period will be honored.

5. PRODUCTS

5.1. MANUFACTURERS

5.1.1. Acceptable Manufacturers (or approved equals):

5.1.1.1. Axis
5.1.1.2. Sony
5.1.1.3. Bosch
5.1.1.4. Approved Equal.

5.2. HIGH DEFINITION INDOOR/OUTDOOR VARI-FOCAL LENS CAMERA

A. Vandal-resistant Mini-Dome Progressive Scan High Definition 1080p (HD) or higher cameras.

B. HD picture quality, multi-streaming, supporting H.264 at 30 fps (IP).

C. True Wide Dynamic Range (WDR) shall be equivalent to 90 dB or higher

D. Advanced 3D noise reduction.

E. Simultaneous encoding of 2 (or more) independently configurable video streams in Zip Stream, H.264 (High/Main/Baseline Profile) and/or MJPEG.

F. IK10-rated vandal-resistant feature: The camera shall be IK10 rated in accordance with the IEC 62262 standard to vandal-resistant feature for protecting the camera from destructive behaviors.

G. 1/3”-type progressive scan CMOS sensor.

H. ~2.8-9mm motorized vari-focal length lens with minimal viewing angle Horizontal: 100 ˚ Vertical: 31 ˚.

I. True Day/Night (D/N) function to switch to Day mode (color mode) or Night mode (black and white mode) depending on the light level.

J. Power PoE or PoE+, 17W Maximum with heater active.

K. Outdoor models: Operating temperature with heater -40 ˚F to 120 ˚F (-20 ˚F to 120 ˚F Startup)

L. Indoor models: Operating temperature with heater +14 ˚F to 120 ˚F

M. Basis of design: Axis P3227-LV (indoor) and P3227-PVE (outdoor) series Axis P3374-LD (infrared interior)

5.3. HIGH DEFINITION INDOOR/OUTDOOR FIXED FOCAL LENGTH LENS CAMERA

5.3.1. Vandal-resistant Micro-Dome Progressive Scan High Definition 1080p (HD) or higher cameras.

5.3.2. HD picture quality, multi-streaming, supporting H.264 at 30 fps (IP).

5.3.3. True Wide Dynamic Range (WDR) shall be equivalent to 90 dB or higher

5.3.4. Advanced 3D noise reduction.

5.3.5. Simultaneous encoding of 2 (or more) independently configurable video streams in Zip Stream, H.264 (High/Main/Baseline Profile) and/or JPEG.

5.3.6. IK10-rated vandal-resistant feature: The camera shall be IK10 rated in accordance with the IEC 62262 standard to vandal-resistant feature for protecting the camera from destructive behaviors.

5.3.7. 1/3”-type progressive scan CMOS sensor.

5.3.8. Field replaceable 2.8mm fixed focal length lens with minimal viewing angle Horizontal: 100 ˚ Vertical: 31 ˚. Lens options of 1.8mm and 4mm shall also be available.

5.3.9. True Day/Night (D/N) function to switch to Day mode (color mode) or Night mode (black and white mode) depending on the light level.

5.3.10. Power PoE or PoE+, 17W Maximum with heater active.

5.3.11. Outdoor models: Operating temperature with heater -40 ˚F to 120 ˚F (-20 ˚F to 120 ˚F Startup)

5.3.12. Indoor models: Operating temperature +14 ˚F to 120 ˚F

5.3.13. Basis of design: Axis P3227-LV (indoor) and P3227-PVE (outdoor) series Axis P3374-LD (infrared interior)

5.4. HIGH DEFINITION PAN/TILT/ZOOM (PTZ) OUTDOOR CAMERA

5.4.1. Self-contained environmental integrated Dome Progressive Scan High Definition 1080p (HD) or higher cameras.

5.4.2. HD picture quality, multi-streaming, supporting H.264 at 30 fps (IP).

5.4.3. Wide Dynamic range (Wide-D) equivalent to 60 dB or higher

5.4.4. Advanced 3D noise reduction.

5.4.5. Simultaneous encoding of 2 (or more) independently configurable video streams in Zip Stream, H.264 (High/Main/Baseline Profile) and/or JPEG.

5.4.6. IK10-rated vandal-resistant feature: The camera shall be IK10 rated in accordance with the IEC 62262 standard to vandal-resistant feature for protecting the camera from destructive behaviors.

5.4.7. 1/3”-type progressive scan CMOS sensor.

5.4.8. ~130mm motorized 30x zoom lens.

5.4.9. True Day/Night (D/N) function to switch to Day mode (color mode) or Night mode (black and white mode) depending on the light level.

5.4.10. Power PoE++, (HPoE) or 24VAC, 60W Maximum with heater active.

5.4.11. Operating temperature with heater -30 ˚F to 120 ˚F (-20 ˚F to 120 ˚F Startup)

5.4.12. Basis of design: Axis P5436-PTZ-E series

5.5. HIGH DEFINITION PAN/TILT/ZOOM (PTZ) INTERIOR CAMERA

5.5.1. Integrated Dome Progressive Scan High Definition 1080p (HD) or higher cameras.

5.5.2. HD picture quality, multi-streaming, supporting H.264 at 30 fps (IP).

5.5.3. Wide Dynamic range (Wide-D) equivalent to 60 dB or higher

5.5.4. Advanced 3D noise reduction.

5.5.5. Simultaneous encoding of 2 (or more) independently configurable video streams in Zip Stream, H.264 (High/Main/Baseline Profile) and/or JPEG.

5.5.6. 1/3”-type progressive scan CMOS sensor.

5.5.7. ~94mm motorized 20x zoom lens.

5.5.8. True Day/Night (D/N) function to switch to Day mode (color mode) or Night mode (black and white mode) depending on the light level.

5.5.9. Power PoE+. Demo existing 24VAC power supplies as required.

5.5.10. Operating temperature with heater +14 ˚F to 120

5.5.11. Basis of design: Axis P5436-PTz series

5.6. HIGH DEFINITION 180/360-DEGREE CAMERA

5.6.1. Integrated Dome Progressive Scan High Definition 1080p (HD) or higher cameras.

5.6.2. HD picture quality, multi-streaming, supporting H.264 at 30 fps (IP).

5.6.3. Wide Dynamic range (Wide-D) equivalent to 60 dB or higher

5.6.4. Advanced 3D noise reduction.

5.6.5. Simultaneous encoding of 2 (or more) independently configurable video streams in Zip Stream, H.264 (High/Main/Baseline Profile) and/or JPEG.

5.6.6. True Day/Night (D/N) function to switch to Day mode (color mode) or Night mode (black and white mode) depending on the light level.

5.6.7. Power PoE+. Demo existing 24VAC power supplies as required.

5.6.8. Basis of design: Axis P3717-PVE series (180-degree) and Axis M3057-PLVE series (360-degree)

5.7. Intercom Camera

5.7.1. Provide Intercom/Camera at Tunnel Entrance
5.7.2. Two-way voice communication to guard station on 1st floor
5.7.3. Camera integrated with Genetec Video system
5.7.4. Remote unlock by guard
5.7.5. Basis of Design: **Axis A8105E Video Door Station**

5.8. MOUNTING HARDWARE

5.8.1. Provide manufacturer mounting hardware as required for all cameras. Cameras may be mounted directly to wall or ceiling surfaces where practical. Proper support will be provided for all drop-in ceiling mounted camera locations.

5.8.2. Drop-in ceiling shall utilize recessed mount with smoke dome whenever possible. Provide T-bar hangers or other acceptable support. Cameras support by the ceiling tile will not be accepted.

5.8.3. Provide pendant wall and pipe mounts at designated locations. Contractor will confirm mounting requirements and provide any needed hardware and mounts for all camera locations.

5.8.4. Exterior camera locations where cameras mount directly to the wall surface will be properly sealed using silicone based caulking to keep water and moisture out of the camera. The bottom edge of the camera will not be sealed to allow for drainage.

6. EXECUTION

6.1. MEDIA CONVERTER INSTALLATION

A. Coaxial to Ethernet media converters shall be used for devices where it is impractical due to cost or access to new cabling pathways to replace the cabling.

B. Media converters shall be installed in a suitable enclosure near the endpoint (camera location). Contractor shall not install non-plenum rated devices in a plenum-rated area unless it is installed in a

suitable enclosure. Contractor will provide suitable metal enclosures for media converters to be installed in plenum rated locations.

C. Provide a factory-terminated patch cable between the media converter and the camera.

D. PoE and PoE+ will be transmitted through the coax to the camera wherever possible.

E. Install rack-mounted multi-port media converters at the cable origination point as required. Connect coax cabling to the media converter. Dress and secure wiring. Assure all cabling is appropriately labeled for identification.

6.2. CATEGORY 6e/6 UNSHIELDED CABLING

6.2.1. All new camera cabling shall be minimally 4-pair UTP category 6e or 6, plenum rated jacket for all indoor applications, and PVC jacketed or direct burial as applicable for cabling installed in outdoor and other non-environmentally conditioned spaces.

6.2.2. Contractor shall coordinate with the Owner to determine requirements for jacket color.

6.2.3. Contractor **shall provide UTP patch panels** in each IDF location and Security wherever camera cabling terminates. Patch panels shall be rack or wall mounted and sized appropriately for the number of camera cable terminations with at least 10% expansion capacity.

6.2.4. All field cabling will terminate at the patch panels then be patched to the Owner's LAN utilizing factory made and terminated patch cable of sufficient length to permit proper cable management.

6.2.5. Network patch cables to be minimally category 6e or 6, factory terminated on both ends, and provided at lengths appropriate for the distance between connected points. Patch cables between active devices shall be a minimum of 1 meter in length.

6.3. CAMERA INSTALLATION

A. Cameras to be installed according to the manufacturer's instructions and recommendations.

B. Install cameras using accepted industry best practices and to a high degree of workmanship. Cameras will be mounted level, and where cameras and mounts have high visibility to the public, aesthetic trim rings flush with the ceiling surface will be utilized, and mounting screws painted to match the color of the mounting hardware in camera locations.

C. Secure cameras to fixed surfaces such as gypsum board or block using manufacturer recommended mounting hardware, faster sizes and types.

D. Exterior cameras and mounts to be sealed with outdoor rated silicon sealant to reduce water and moisture penetration at the point where the equipment attaches to the wall surface and conduit connections to the camera housing. Silicon sealant will be clear or match wall color. Mounting hardware color will be selected and painted as necessary to maintain aesthetics.

E. Aim and focus cameras locally using a laptop or portable NTSC monitor utilizing the camera's built-in analog output or web interface.

F. Camera views shall be configured to fully capture the area to be monitored. Only a small amount of ceiling may be visible in the view.

G. Work with owner to configure cameras in the VMS software, set all view and recording stream parameters, verify correct operation.

H. All cameras shall be PoE wherever possible. PTZ cameras shall be powered via PoE+ or PoE++. Demo obsolete 24VAC power supplies when not reused.

6.4. WIRE MANAGEMENT AND DEMOLITION OF OBSOLETE EQUIPMENT

6.4.1. All cabling in IDF racks shall be patched and neatly dressed and managed.

6.4.2. All field cabling, both Category 6e/6 shall terminate to patch panels, then be patched to the connecting equipment using factory made patch cables. Patch cable shall be provided at lengths suitable to provide sufficient routing for cable management, but also without undue excess length.

6.4.3. Any existing coax that is to be reused for IP transmission (via media converters) shall be cut back and connected to BNC patch panels (provided and installed by the Contractor) then patched to the media converters.

6.4.4. Patch coax from the patch panel to the media converters using micro RG-59U patch cables. Dress and manage cables for a neat and professional installation.

6.4.5. Cut back and dress all coax cabling that is no longer to be used, Relocate wire labeling before cutting cables back to keep wires properly identified. Maintain enough wire length so that the wire may be connected to a patch panel and reused in the future.

6.4.6. Demo all unused equipment and turn over to the owner.

6.4.7. Clean up and dress any additional wiring, power cords, etc. for a finished well managed installation.

END OF SECTION 28 23 29

Part 7 - Scope of Work

7.1. Scope of Work

Contractor shall supply all necessary equipment, parts and labor for installation of:

7.1.1. QUANTITY (##) security cameras and accessories as described herein.
7.1.2. QUANTITY (##) device licenses with 5 year Genetec SSA Maintenance
7.1.3. One Video Archiver server to support these 116 cameras

7.2. Schedule Requirements

Contractor must adhere to the following schedule:

7.2.1. Installation of wiring, cameras, and security equipment may **begin on XXXXXXX**.
7.2.2. Termination, labeling, and testing of all other outlets completed **by XXXXXXX**
7.2.3. All documentation to be submitted **by XXXXXXX**
7.2.4. Project Total Completion Date **by XXXXXXX**

7.3. General

7.4. Project Manager Contact <AND> Technical Contact

Coordinator of Physical Security Systems
New York State University Police Department
735 Anderson Hill Road
Purchase, NY 10577-1400
(914) 251-6900

Campus Technology Services
735 Anderson Hill Road
Purchase, NY 10577-1400
(914) 251-6465

7.5. Owner Building Manager Contact

Building Manager
Some Building
735 Anderson Hill Road
Purchase, NY 10577-1400
(914) 251-XXXX

7.6. Any conditions identified “that impose obstructions” in the initial site survey must be submitted in writing at the time of the site survey. All objects (specifically artwork) that “impose obstructions” will be brought to the attention of Owner Building Manager Contact (or designee) prior to being touched or moved.

7.6.1. Contractor shall furnish and install cameras, licenses, patch cables, and other hardware required for delivery of a complete and a working turnkey security system as described herein.

7.6.2. Contractor shall furnish and install raceway, duct, conduit, J-Hooks, Loop/Strap Cable Hangers, and cable tray to supplement existing pathways where necessary in order to perform the scope of work described herein. Raceway, troughs and any other pathway components that will be visible in public spaces (galleries) will be subject to inspection and approval by the Building Manager prior to purchase and installation. Sample components should be provided to the Owner Building Manager at least one week prior to purchase for approval by the Owner Building Manager.

7.6.3. Contractor shall provide for testing of the installed security systems in the scope of work as described herein, and shall submit test results in electronic and hard-copy format to Owner immediately following testing.

7.6.4. Contractor shall provide as-built documentation of the installed cabling systems in AutoCAD or Visio format for the scope of work described herein, and shall submit documentation to Owner immediately following labeling and testing.

7.6.5. Data/Telecommunications Cabling System

Installed Category 6 / 6A system and components shall support 100BASE-TX Ethernet as per IEEE 802.3u, 1000BASE-T Ethernet as per IEEE 802.3ab, 1000BASE-TX Ethernet as per TIA-854, 2.5GBASE-T and 5GBASE-T Ethernet as per IEEE 802.3bz, 10GBASE-T Ethernet as per IEEE 802.3an, Voice-Over-IP telephony (VOIP) as per TIA-TR41, digital telephony as per TIA-810-B, analog telephony as per TIA 470-C, and Power over Ethernet as per the IEEE 802.3af, IEEE802.3at, and IEEE802.3bt standards.

7.6.6. Fiber-Optic Cabling

All of the necessary fiber optic cabling to be provided by others. The Fiber-Optic portion of the Data/Telecommunications Cabling System shall support 1000BASE-LX as per IEEE 802.3 Clause 38, 1000BASE-X as per IEEE 802.3z, and10GBASE-LR as per IEEE 802.3ae.

7.7. Staging and Jobsite Storage

Contractor shall use Room XX0002 for staging and storing materials while working.

7.8. Patch Cables

7.8.1. Category 6 Booted Patch Cables

Contractor shall supply (furnish only) a number of Category 6 booted patch cable**s** equal to twice the total the total number of Category 6 devices installed.

Patch cables shall be shipped to Owner Project Manager in boxes, and shall be sized as follows:

7.8.1.1. Half (50%) of the total number of Category-6 booted patch cables supplied shall be one (1) foot in length

7.8.1.2. Half (50%) of the total number of Category-6 booted patch cables supplied shall be two (2) feet in length.

For each pair of patch cables provided:

Contractor to install one Cat 6 patch cable to connect end-point device to edge port provided for that device.

The College will install one Cat 6 patch cable to connect edge ports to switches.

7.8.2. Category 6A Booted Patch Cables

Contractor shall supply (furnish only) a number of Category 6A booted patch cable**s** equal to twice the total number of Category 6A cables installed.

Patch cables shall be shipped to Owner Project Manager in boxes, and shall be sized as follows:

7.8.2.1. Half (50%) of the total number of Category-6a booted patch cables supplied shall be one (1) foot in length

7.8.2.2. Half (50%) of the total number of Category-6a booted patch cables supplied shall be two (2) feet in length.

For each pair of patch cables provided:

Contractor to install one Cat 6A patch cable to connect end-point device to edge port provided for that device.

The College will install one Cat 6A patch cable to connect edge ports to switches.

7.9. Communications Room

Install the following components in all specified Communications Rooms.

Prepare Communications Rooms for installation of cables and equipment.

Exact placement of installed materials in data/telecommunication Communications Rooms shall be approved by Owner Technical Contact prior to permanent installation.

7.9.1. Power Supplies and POE repeaters

If necessary, POE repeaters will be installed for any runs that exceed Ethernet distance limits.

7.9.2. Other Pathway – If Necessary

7.9.2.1. General

J-Hooks or Loop/Strap Cable Hangers shall be used as cable support above accessible ceilings when main pathway is not specified.

J-Hooks or Loop/Strap Cable Hangers shall be used as cable support in open (unfinished) ceiling areas of basement level.

Unless otherwise specified, EMT, J-hooks, or Loop/Strap Cable Hangers shall be used as cable support above plaster and gypsum board ceilings where ceiling contains a viable space to which access is available via new or existing Ceiling Access Hatches, or where light fixtures may be removed in order to provide access to area above ceiling.

7.9.2.2. Exceptions

7.9.2.2.1. Ceilings Without Viable Space

In the following areas, where plaster ceiling does not contain viable space, it shall be acceptable to fish/rod suitably-sized plenum innerduct on top side of finished ceiling or (more preferably) through trussing without support, and pull cables through plenum innerduct to each location specified in drawings:

7.9.2.2.1.1. XX1005 1st Floor Lobby

7.9.2.2.2. Stairways and Mechanical Rooms

Cable run in and through stairways and mechanical rooms shall be run in surface-mounted EMT for the entirety of their span in stairways and mechanical rooms. .

J-Hooks and cables must not be visible in stairways, rooms, and hallways, except as otherwise noted.

7.9.2.3. Cable Transition from Ceiling (horizontal) to Walls (vertical) Near Outlet Location

Unless otherwise noted, if it is at all possible to snake a wall to outlet location, then cable shall transition from ceiling height into finished wall via minimum ¾" EMT sweep installed in wall, and be snaked down (behind) finished wall to be terminated in Low-Voltage Faceplate Mounting Bracket.

Cable for outlets located in any stairway or mechanical room regardless of ceilings type or ability to snake wall shall remain in surface-mounted EMT in stairways and mechanical rooms and shall terminate in a surface-mounted metallic box.

Unless otherwise noted, if wall cannot be snaked from ceiling, then:

7.9.2.3.1. Cable for outlets located in any room with unfinished (opened) ceilings shall transition to surface-mounted EMT and shall terminate in a surface-mounted metallic box.

7.9.2.3.2. Cable with outlets located in any room with finished ceiling shall transition to non-metallic raceway and shall terminate in surface-mount non-metallic box.

7.9.2.4. Access Hatch Installation – If Necessary

Contractor may install an approved metallic plenum-rated access hatch wherever access to inaccessible ceiling is necessary in order to install cables and pathway above ceiling.

Plans for new access hatch installation must be presented in advance to Owner Project Manager and Owner Building Manager Contact for written approval.

7.9.3. Camera Locations and Counts

Provide and install Cameras as marked in floorplans. See Building-Floorplan

Also see the attached workbook "Camera-Counts-Locations.xlsx" for the locations. A sample excerpt is shown below:

			Camera Locations			
2	**Level**	**Room**	**In/Out**	**camera type**	**quantity**	**Accessories**
3	Basement	XX0000	Indoor	Standard Dome - Hi Traffic	4	None
4	Basement	XX0001	Indoor	360-Dome	9	Pole and Pole Mount
5	1st floor	XX0002	Outdoor	180-Dome	1	Wall Mount Kit
6	1st floor	XX0003	Outdoor	180-Dome	1	Wall Mount Kit
7	Basement	XX0004	Indoor	Standard Dome - Hi Traffic	1	Wall Mount Kit
8	1st floor	XX0005	Indoor	Standard Dome - Hi Traffic	2	Wall Mount Kit

Please return "Camera-Counts-Locations.xlsx" workbook with your bid submittal

7.9.3.1. Configuration by NYSUP personnel

7.9.3.1.1. All cameras should be delivered to UPD technical contact in original unopened boxes for a period of at least two weeks to allow UPD staff to configure and label the devices.

7.9.3.1.2. All necessary Genetec licenses and SSA agreements will also be made available on the Genetec Portal site to NYSUP for a period of at least two weeks to allow UPD staff to configure and label the devices.

7.9.3.1.3. Configured devices will labelled and returned to the contractor for installation.

7.9.3.1.4. Labels will correspond to the floorplan.

7.9.3.2. Naming Convention

Device Naming Convention

Building	Device Type	Floor	Sequence	3rd Octet of device IP address *	4th Octet of device IP address *			
XX	CA = Camera	0 = Basement	01	XX	XX			
	CR = Card Reader	1 = First Floor	02					
	DS = Door Sensor	2 = Second Floor	03	N.A.	N.A.			
	RE = Repeater	3 = Turd Floor	04	N.A.	N.A.			
	KP = Alarm Keypad	4 = Fourth Floor	etc	N.A.	N.A.			
	ZX = Zone Expander			N.A.	N.A.			
	AP = Alarm Panel							
	MS = Motion Sensor			N.A.	N.A.			
	* For non-IP devices, (like door sensor / Motion Detector) use "XX.XX"							
Result:								
XX	AP	1	14	XX	XX	=	XX-AP-001-16.118	Alarm Panel
XX	DS	1	12	XX	XX	=	XX-DS-112	Door Sensor #12 on 1st floor
XX	MS	3	16	XX	XX	=	XX-MS-316	Motion Detector #16 on 3rd floor
XX	CR	1	08	XX	XX	=	XX-CR-108.16.106	

7.9.3.3. Exterior Cameras

Cat-6 cables for the XX cameras and the 2 wired card readers that are to be attached to the exterior of the building are inside the building and are coiled with 30' slack nearby in marked locations. This is to allow the security contractor to properly locate the exterior cameras to achieve the optimum vantage point.

The winning vendor will make the penetration through the exterior wall, feed the cable through, and seal the penetration against water. Eight of the exterior cameras will be mounted to the brickwork on the exterior of the building at a height of approximately 10' above the ground to provide the best vantage point.

One exterior camera is in the XXXXX and shall be affixed to the EMT box where the cable is terminated opposite the XXXXX door.

7.9.3.4. Tunnel Level Camera

Successful bidder will also install one camera in the South Tunnel to provide a complete view outside the service entrance to the building. The cabling for this camera is already present.

7.9.3.5. Wall-mounted Surveillance Cameras

Mount the camera to the wall using the appropriate manufacturers mounting hardware. Attach Cat 6A patch cable from camera to nearby port provided for that camera.

7.9.3.6. Ceiling-mounted Surveillance Cameras

1.5.3.2.1) Acoustic Ceiling Tile (ACT):

Where a ceiling-mounted camera is specified to be installed below an accessible Acoustic Ceiling Tile (ACT) ceiling, contractor shall utilize recessed mount with smoke dome whenever possible. Cameras must be installed using the appropriate manufacturers mounting hardware. Provide T-bar hangers or other acceptable support. Cameras supported by the ceiling tile *will not be accepted*.

7.9.3.7. Gypsum Board or Plaster Ceilings

where a ceiling-mounted Surveillance Camera is specified to be installed below a gypsum board or plaster ceiling, contractor shall utilize recessed mount with smoke dome whenever possible. Cameras must be installed using the appropriate manufacturers mounting hardware.

7.9.3.8. Pole-Mounted cameras
in some locations poles will be required from the ceiling to reach an unobstructed vantage point (i.e. XX0007.) Poles and any accessories will use the appropriate manufacturer's hardware.

7.9.3.9. Pole mounted cameras must have an unobstructed view – yet be as close to the ceiling as possible to avoid obstructing gallery sightlines as defined and instructed by owner/building manager contact.

7.10. Coordinate cutover to newly-installed cable with Owner Technical Contact and Owner Building Manager, following completion of installation.

7.11. Following successful cutover to newly-installed cable, and with written permission of the Owner Project Manager, remove all abandoned cabling that was replaced by the newly-installed Category 6 cable. Removal of Abandoned Coax, 18x2, Category-5, Category-5e, and Category 6 Cable serving existing legacy cameras as per NFPA/NEC code.

7.12. Remove existing legacy security devices – cameras, motion detection, etc.

7.13. Video Server and Storage Hardware

7.13.1. Successful vendor will procure and provide QUANTITY (#) "Archiver" servers to support the new cameras being installed in this building.

7.13.2. Genetec "Archiver" server will meet the following minimum specifications:

7.13.2.1. Intel Xeon E5 Processor, 4 Cores, 2.6Hgz
7.13.2.2. 32GB RAM
7.13.2.3. OS Drive 250GB SSD
7.13.2.4. Windows 2016 or above
7.13.2.5. Dual 1-Gigabit NIC or above
7.13.2.6. DVD ROM
7.13.2.7. 3-Year, next business day onsite factory maintenance and warranty included.

7.13.2.8. Basis of design: BCD or Dell R620 series.

7.13.3. Archiver Server will be procured and provided to Purchase Campus Technology Services (CTS) in unopened manufacturer packaging. CTS will rack the server and configure it for ongoing operation by University Police personnel.

7.13.4. Monthly average camera Storage calculations will be provided as specified in Section 2.4.

7.13.5. Disk storage to be provided by others.

7.14. Licensing

7.14.1. Successful vendor will provide QUANTITY licenses to support the IP cameras being installed. This will include:

7.14.1.1. Genetec Initial Device License
7.14.1.2. Genetec Software Service Agreement (SSA) license for a period of five (5) years

7.15. Shelf Stock

7.15.1. In addition to the cameras to be installed, an additional quantity of "Shelf Stock" cameras are to be provided. These cameras will be identical to the types of cameras being installed.

7.15.2. Shelf Stock cameras do NOT require licensing as they are to be used as replacements.

7.15.3. Shelf Stock to be provided in the following quantities:

7.15.3.1. Two (2) Interior fixed-focal length cameras
7.15.3.2. Two (2) Exterior Fixed Focal-length cameras
7.15.3.3. Two (2) Interior 360-degree dome cameras

7.16. Attachments

See attached diagrams and documentation for further description of Scope of Work.

7.16.1. Drawing "Building-Floorplan"
7.16.2. Spreadsheet "Camera-Card-Bid-Estimators-Workbook.xlsx"
7.16.3. Spreadsheet "Bandwidth-Storage-Calculation-Workbook.xlsx"
7.16.4. Spreadsheet "Camera-Counts-Locations.xlsx"
7.16.5. Spreadsheet "Device-Naming-Convention.xlsx"

Terms and Conditions for Working at Purchase College

All bidders, contractors and subcontractors must sign (or be included under signature) and be apprised of the terms of the Non-Disclosure Agreement. For any projects involving sensitive information the college will provide an account to access sensitive information Storage or transmission of sensitive information through email or other third-party software is prohibited, no exceptions.

All work at the college must be compliant with the requirements and procedures provided by the Purchase College Office of Environmental, Health and Safety on their website and in their Environmental, Health & Safety Contractor Guidelines brochure. This encompasses fire safety and hot work procedures, which will be **strictly enforced**.

All means of egress must be accessible and clear through construction, and must not be blocked by construction equipment or materials. Site visits by OEHS officers should be expected, to confirm the safety of the public, employees and contractors.

Plans for any alterations to the building must be presented in advance as part of the scope of work to Building Manager and/or Project Manager for approval. If field conditions present unforeseen alterations, these must be approved in writing by owner prior to any work commencing.

It is the responsibility of the contractor to ascertain that all building elements (roofs, walls, windows, skylights, etc.) and systems (drains, pipes, pumps, fan coils, sprinklers, etc) will be protected against water entering or escaping. It is the responsibility of the contractor that the interior and all of its contents (including offices, public and storage/office/workshop spaces, materials and equipment, etc.) will be protected from water and moisture. The contract will specifically describe the means and materials for covering the roof and protecting the building interior while work is in progress. The contractor will include in the bid all materials, labor and equipment required to prevent any water or moisture from entering the interior.

Any area of a roof (and its component elements, e.g. membrane, flashing, etc.) or walls (and their component elements, e.g. bricks, pointing, etc.) under construction will be completely secured against water infiltration before work stops each day. No area of the roof shall be left open unattended for any amount of time. Building Manager contact will be notified 48 hours in advance of work requiring the removal or trial of water bearing systems, roof, skylight or any open portal. The contractor will include an add alternate in their estimate means for temporary air handling in artwork storage areas that includes humidity control and a humidity monitoring device or system.

The contractor will control and capture dust, grit, and other abrasives.

As needed, temporary barriers, the nature and location of which, will be constructed according to the recommendation of and determination of the Building Manager and/or Project Manager.

Areas of the building should be compartmentalized to protect against dust and fumes entering other areas of the building. If necessary, sealed areas will include a ceiling and mechanism for exhausting plaster, sawdust, fumes etc. out of the building. Cleaning is required at the completion of each phase of work in each area. Dust cannot be allowed to accumulate over the duration of the project. The contract

will identify the means and methods for preventing and/or removing particulate from air delivery systems (chases and duct paths) prior to completion of the project.

The contractor is responsible for returning all spaces to their original condition and functionality, including all repairs to damage incurred during construction. All finishes (level of plaster and paint finish, carpeting, etc.) and cleaning (debris and dust, stains, etc.) must be returned to prior condition.

The schedule and (sub) contractors conducting this work will be agreed to in advance by the Building Manager. If restoration work is known prior to the initiation of work, it should be priced within the bid as an add-alternate. Any preconditions in the contractor's work area requiring repair should be noted in writing for the Building Manager's records.

Any work within the project scope requiring subcontracting by trades besides that of the contractor is the responsibility of the contractor. Subcontracting will follow the policies and procedures defined by the Purchase College Office of Purchasing and Accounts Payable on their website, and as outlined in the Purchasing Policy and Procedure Manual. Subcontractors and the scope of their work must be approved by the NMA, and when requested, the Purchase College Office of Facilities Management and/or Capital Facilities Planning.

If asbestos testing, remediation and monitoring is required, this scope and schedule must be approved by the Building Manager and the Purchase College Office of Environmental, Health and Safety at least four to six months in advance to allow for processing all New York State variances required. This work must be done by a subcontractor approved by the Building Manager and OEHS as part of the scope and budget of the project.

If any security devices (cameras, motion sensors, door access control, etc.) must be moved, disabled or altered in any way, this work must be done by a subcontractor approved by Building Manager, UPD and Campus Technology Services as part of the scope and budget of the project. If field conditions during the project require that security devices be moved, disabled or altered, contractors must inform the Building Manager and/or Project Manager and the University Police Department immediately, prior to commencing any work. If any network equipment (wireless access points, cables, etc.) must be moved, disabled or altered in any way, this work must be done by a subcontractor approved by both the Building Manager and/or Project Manager and network managers at CTS as part of the scope and budget of the project. If field conditions during the project require that network equipment be moved, disabled or altered, contractors must inform the Building Manager and/or Project Manager and CTS immediately, prior to commencing any work.

The contractor will supply all equipment, materials and tools for the execution and completion of the scope of work defined herein. Delivery dates and storage location of equipment, materials and tools will be agreed to by the Building Manager and/or Project Manager. Equipment and material storage must not block means of egress (per code), nor any areas in which the public or college staff require functionality. Delivery and return of rental equipment will be the responsibility of the contractor, occurring only during hours agreed to by the Building Manager.

Contractors will plan and coordinate all work schedules with the Building Manager and/or Project Manager. As college schedules are predetermined and detailed, contractor scheduling must conform to that of the college to protect the safety of the public, employees and students.

Contractors must provide the Building Manager and/or Project Manager with a detailed work schedule specifying the names of contractor personnel who will be working in the facility, the dates they will be working, and the general location and description of tasks they will be working on. Weekly updates to this work schedule will be provided.

If power to any part of the building is to be interrupted for any reason, the Building Manager and/or Project Manager must be notified at least 48 hours ahead of time.

All workers employed by, sub-contracted by, or otherwise being used by the Contractor will comply with the college's security policies and protocols, including presenting photo ID upon request, signing in and out for each instance of entry/egress, and using authorized entrance/exit points for both personnel and materials. All bags, packages, toolboxes, trash and any other materials that are carried into or out of the college may be subject to inspection by college personnel.

The Building Manager and/or Project Manager (or designee) may issue an immediate stop-work order to the acting contractor site manager for any reason if they determine that there is a danger to the students, facility, or personnel. The Building Manager and/or Project Manager may convey a "field-directed change" to address the issue.

Any conditions identified that impose obstructions in the initial site survey must be submitted in writing at the time of the site survey. Any objects in proximity to the contractor's work (including and particularly artwork) will be brought to the attention of the Building Manager and/or Project Manager (or designee) so that they may be moved. Objects constituting artwork will be determined by the Building Manager and/or Project Manager (or designee) and not by contractors. **Contractor personnel will not touch any art work.** Artwork will only be touched or moved by college staff.

Contractors must observe college policy regarding food, beverages and smoking, extraneous noise and language appropriate to a professional work place. Contractors must yield to visitors in public spaces (e.g. allowing tours and classes to pass unobstructed, ceding elevator to visitors, etc.). The Building Manager will provide the contractor with times and locations in which tours or events are occurring; contractors must halt work and cease noise in those areas during those times.

Contractor will work with the Purchase College campus towards disposal of waste (including dumpster if necessary). Removal of all waste (inclusive of construction debris, materials waste and trash) will be scheduled with Building Manager and/or Project Manager, and only removed through approved exits at specified times. All waste will be inspected by guard prior to removal from building.

Parking permits for designated areas can be obtained through the Purchase College Office of Parking and Transportation. Parking permits, tickets and any fines incurred are the sole responsibility of the contractor.

***** END OF DOCUMENT *****

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SPECIFICATIONS GROUP

Site and Infrastructure Subgroup

DIVISION 31 - EARTHWORK

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SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections:
1. Division 31 Section Erosion and Sediment Control – for temporary erosion and sedimentation control measures
2. Division 02 Section Site Demolition – for demolition of structures and site improvements

1.02 SUMMARY

A. Section Includes:
1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities
7. Temporary erosion- and sedimentation-control measures.

1.03 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed photographs or videotape.
   2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.06 QUALITY ASSURANCE

A. Pre-Installation Conference: Conduct conference at Project site.

1.07 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service and “Call Before You Dig” for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

D. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Impoundment of water.
   4. Excavation or other digging unless otherwise indicated.
   5. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

F. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section 312000 Earthwork.
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide all means necessary to install, inspect and maintain, and remove temporary erosion and sediment control measures as shown on the drawings and as required to minimize the erosion and unspecified transport of soil and sediment from the site.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section 015639 Tree and Plant Protection.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.04 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
   1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
   1. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be removed.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than seven days in advance of proposed utility interruptions.

E. Excavate for and remove underground utilities indicated to be removed.

3.05 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Remove stumps and remove roots dispose of offsite.
   3. Use only hand methods for grubbing within protection zones.
   4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

3.06 TOPSOIL STRIPPING

A. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   1. Limit height of topsoil stockpiles to 10 feet
   2. Do not stockpile topsoil within protection zones.
   3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.07 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, pavements, curbs, and aggregate base as indicated.

3.08 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

SECTION 31 15 00

SITE PREPARATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related specification sections include but are not limited to:
   1. Division 02 Section 024120 Site Demolition
   2. Division 01 Section 015639 Temporary Tree and Plant Protection

1.02 DESCRIPTION OF WORK:

A. The work of this Section, includes all labor, materials, necessary equipment, appliances, materials and services for any reasonable incidental to complete the Site Improvements and related work indicated on the drawings and/or specified herein including but not necessarily limited to the following:
   1. Demolition of existing pavements, utility infrastructure, and all associated below-grade structures (foundations, manholes, etc.) including removal of all debris as indicated on the plans.
   2. Protection and trimming of existing trees.
   3. Installation and maintenance of Erosion and Sediment Control devices prior to any earthwork operations. Includes the placement, replacement and relocation of erosion and sediment controls in accordance with the New York State Standards and Specifications for Erosion and Sediment Control.
   4. Clearing and grubbing.
   5. Removal off-site of tree stumps and other vegetation.
   6. Stripping, storing and the on-site reuse of topsoil.
   7. Disposal off-site of excess excavated material and/or excavated materials not suitable for backfilling including the removal of all combustible or other organic material.
   8. Supply and placement of acceptable fill material to maintain the elevations shown on the drawings.
   9. Excavation, backfilling, compaction and preparation of subgrade for roadways, yards, lawns, sidewalks, walkways and driveways as shown on the drawings and as required. Maintain temporary surface drainage and erosion control of the site.
   10. Backfilling to grade against footings, foundations, utility chambers, electrical vaults, retaining walls, manholes, field inlets/catch basins, trenches and other items of work as hereinafter specified.
   11. Excavation, sheeting, shoring, placement of base material and backfilling for utilities including storm, sanitary sewer and water mains.
   12. Excavation, sheeting, shoring, placement of base material and backfilling for mechanical and electrical work, including excavation and installation of light pole bases.
   13. All necessary pumping and dewatering, including settling basins.
   14. Responsibility for all necessary trade union contract provisions during the site clearing and excavation work of this Section as well as throughout the project.
   15. Maintenance of access to the site.

16. Layout of line and grade to perform the work as shown on the drawings and contained in the Specifications.
17. Disconnection, removal or abandonment of all existing utility lines including but not limited to, poles, pipes, ductbanks, manholes, vaults, boxes and conduits not required on the site.
18. Installation of site utilities including domestic water, fire protection, hydrants and storm drainage.
19. The removal of existing and the installation of new site lighting and signage where indicated on the plans.
20. The removal of existing and the installation of new sidewalks, walkways, driveways and wheel stops as shown on the drawings and contained in the Specifications.
21. Make connections into existing utilities as shown on the plans including all excavation, sheeting and shoring, trenching, laying of pipe and conduit, abandonment and/or removal of existing structures, repair of damage to existing structures and utilities, construction and installation of new structures, backfilling, compaction and landscaping.
22. Excavation, compaction, grading and placement of paving as shown on the Plans.
23. Obtaining all permits required for the above work, including the payment of all associated and/or bonds associated therewith.
24. Cleaning and testing of all new water mains, and storm drainage facilities.
25. Excavation, grading and fencing required to complete the installation of drainage structures, stormwater basins, control manholes, drain inlets, storm pipes, and drainage swales.
26. Maintenance of stream flows and drainage ways at all times during construction.

1.03 REFERENCE STANDARDS:

A. Work of this contract which is not specified herein shall conform as applicable to the "Standard Construction Specifications and Standard Construction Details" of the New York State Department of Transportation, the “New York State Standards and Specifications for Erosion Control,” and the project’s approved “Stormwater Pollution Prevention Plan (SWPPP).”

PART 2 – NOT USED

PART 3 – EXECUTION

3.01 RESPONSIBILITY OF CONTRACTOR:

A. General
   1. The Contractor shall do all the work and shall furnish all the materials, tools and appliances necessary or proper for performing and completing the work required by this contract to the satisfaction of the Owner's Representative and Construction Manager in accordance with the specifications and drawings herein mentioned.

B. Protection of Existing Improvements
   1. Provide barricades, coverings or other types of protection necessary to prevent damage to existing improvements indicated to remain in place.
   2. Protect improvements on adjoining properties as well as those on the Owner's property.
   3. Restore any improvements damaged by this work to their original condition, as acceptable to the owner and other parties or authorities having jurisdiction.

C. Protection of Existing Trees and Vegetation
   1. Protection of existing trees and other vegetation if and as indicated to remain in place is the responsibility of the Contractor. Protection systems once installed shall be maintained by the

Contractor and shall not be removed or disturbed without the approval of either the Owner or Construction Manager.

2. Comply with the protection requirements indicated in Division 01 Section 015639 Tree Protection and Pruning.

D. Permits

1. The Contractor shall, at his own expense, obtain all the necessary permits and licenses required by Town, County, State or other public authorities; shall give all notices required by law or ordinances; and shall post all Bonds and pay all fees and charges incident to the due and lawful prosecution of the work covered by this Contract. If any of the Contractor's work shall be done contrary to such laws, ordinances, rules and regulations without such notice, the contractor shall bear all cost arising therefrom.

E. Prevention of Dust Hazard

1. The Contractor agrees that in the event a silica or other harmful dust hazard is created in the construction of the work herein contracted to be done, and for which appliances or methods for the elimination of such silica dust or other harmful dust have been approved by the State or governing authorities having jurisdiction, said Contractor will install, maintain and keep in effective operation such appliances and methods for the elimination of such silica dust or other harmful dust hazard or hazards, and in the event this provision is not complied with, this contract shall be void.

F. Existing Utilities

1. Under Section 119B of the Public Service Law, Article 36 of the General Business Law and Industrial Code Rule 53, the Contractor is required to:
   a. Contact Underground Facilities Protective Organization (UFPO at 1-800-962-7962) at least three full working days prior to the start of work.
   b. Verify the precise locations of the underground facilities, once the buried utilities are marked.
   c. Protect and preserve utility stakings, markings or other designations.
   d. Provide support and prevent damage to any underground facility or its protective coating.
   e. Understand and use the State Color Code for facility markings.
2. Final locations of such utilities identified in the field are to be field located by the Contractor using careful hand excavation prior to the conduct of the Work.
3. No assurance can be given that the locations of the existing subsurface utility lines shown on the plans are entirely correct or complete. Final locations shall be field located by each utility operator.
4. Do not interrupt existing utilities serving facilities occupied and used by others, except when permitted in writing by the Owner's Representative and then only after acceptable temporary utility services have been provided.
5. It shall be the Contractor's responsibility to protect all existing utilities from damage during all phases of construction, whether or not said utilities have been located by the Utility. Location work which is to be done by the Utility (or Private Forces) as specified under Paragraph F.1 and F.2 above is to be done as an aid and guide for the Contractor's operations and is not guaranteed to be exact and said location work shall not be made the basis of any claim for additional compensation by the Contractor if existing utilities are damaged by any of the Contractor's operations.

   The Contractor shall exercise extreme care during all excavation and backfilling operations and any existing utility, pavement, curb, etc. which becomes damaged due to any of the Contractor's operations shall be replaced or repaired to the satisfaction of the Owner's.

G. Traffic Regulation

1. The Contractor shall regulate and maintain traffic, post construction and detour signs and do such work as may be required for the proper safeguarding and handling of all traffic both on and off-site. Such traffic regulations shall be in accordance with the requirements of the New York State Department of Transportation and the New York State Department of Public Safety.
2. As set forth on the plans or as ordered by the Owner, streets along the line of work shall be maintained in one or both directions. Occupants of the facility along the line of work or persons having business with such occupants shall have safe means of ingress and egress at all times. Access to all driveways shall be maintained at all times. Fire, police and emergency personnel and equipment shall have safe and adequate access at all times to all portions of the line of work. When so directed, the Contractor shall provide approved safe and adequate temporary bridging over newly-built work to protect the work from any injury which might result from traffic.
3. Unless otherwise specified, no direct payment will be made for regulating and maintaining traffic, compensation for same being considered as included in the prices bid for the work of the contract.
4. The Contractor shall supply and maintain all lights, flares, torches, fences, barricades, steel plates, flagperson and/or other protection devices necessary to adequately protect traffic during construction.
5. A detailed construction phasing plan shall be prepared by the contractor which shall include scope, duration, traffic and safety control measures both on and off-site. The phasing plan included on the contract documents provides the overall sequence of work for all trades. The contractor shall modify the plan as needed to maintain safe and adequate access to the facility at all times. At no time will access to the facility be closed without written approval by the Owner.
6. The Contractor shall notify the Owner’s representative and/or the Construction Manager at least 72 hours in advance of any change in on-site circulation patterns so that notification may be given to local emergency service providers.

H. Nuisances
1. The Contractor shall avoid injury to persons and, so far as possible, all odors, smoke, noise, nuisance, vibration or disturbances, as from machinery, pumping, air compressing, blasting, blacksmithing or trucking, and the contractor shall be liable for all damages therefrom or for violation of any and all related present and future local laws, ordinances or regulations or otherwise. Approved silencers shall be installed on noise making equipment.

I. Sanitary
1. The Contractor will be required to strictly observe the sanitary rules and regulations of the State and County Departments of Health.
2. The Contractor shall prohibit and prevent the committing of nuisances on the site of the work. When directed by the Owner's Representative, the contractor shall summarily discharge any and every employee who commits a nuisance. Sanitary precautions shall at all times be satisfactory to the Owner's Representative.

3.02 SITE CLEARING:

A. Clearing and Grubbing
1. Remove curbing, pipes, catch basins, manholes, subsurface structures and other improvements or obstructions that interfere with installation of new construction. Also, remove such items elsewhere on the site or premises as specifically indicated.

B. Topsoil Removal

1. Strip Topsoil to whatever depths encountered and in such a manner so as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
2. Where trees are indicated to remain, stop topsoil stripping a sufficient distance from such trees to prevent damage to their main root system.
3. Refer also to Division 31 Section 311000 Site Clearing of these specifications.

3.03 EROSION AND SEDIMENT CONTROL:

A. Refer also to Division 31 Section 311750 Erosion and Sediment Control of these specifications.

3.04 DISPOSAL OF WASTE MATERIALS:

A. Burning of combustible cleared and grubbed materials is not permitted on the Owner's property.

B. Removal from the Owner's Property - Remove all waste materials including any unsuitable backfill material from the Owner's property and legally dispose of it.

3.05 SURVEY LAYOUT OF WORK:

A. The Contractor to provide mathematical delineation of all critical horizontal and vertical points for the entrance roads, driveways, parking areas, walkways and underground utilities. In addition, reference points shall be in the New York State Planar Grid System.

B. Layout and stake all required grades and lines. This work shall be done by a New York State Licensed Land Surveyor employed by the Contractor and approved by the Owner's Representative and/or the Construction Manager.

C. Carefully maintain all bench marks, monuments and other reference points, and if they are disturbed or destroyed through operations of the Contractor, they shall be replaced in a manner satisfactory to the Owner's Representative at the Contractor's expense.

END OF SECTION 31 15 00

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SECTION 31 17 50

EROSION AND SEDIMENT CONTROL

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 DESCRIPTION OF WORK:

A. Provide all means necessary to install, inspect and maintain, and remove temporary erosion and sediment control measures as shown on the drawings and as required to minimize the erosion and unspecified transport of soil and sediment from the site. THE CONTRACTOR SHALL MAINTAIN LESS THAN 5 ACRES OF SITE DISTURBANCE.

1.03 QUALITY ASSURANCE:

A. General

1. Install and maintain all soil erosion and sediment control measures in compliance with the New York State Department of Environmental Conservation General Permit for Storm Water Discharges from Construction Activities.
   a. Retain a copy of the project's Notice on Intent (NOI); a brief description of the project, posted in a prominent place for public viewing; and a copy of the project's Storm Water Pollution Prevention Plan (SWPPP) at the construction site from the date of initiation of construction activities to the date of the Notice of Termination (NOT) submission.

2. Contractor shall thoroughly review the project's SWPPP incorporated herein by reference, as well as the erosion and sediment control plans and shall implement all measures required in the plans, prior to the start of any other activities on site.

3. Install all erosion and sediment controls in accordance with the drawings and/or the latest edition of the *New York State Standards and Specifications For Erosion And Sediment Control, August 2005* (N.Y.S. Guidelines).

4. Grade and maintain site at all times such that all storm water runoff from disturbed areas is diverted to soil erosion and sedimentation control facilities.

5. No changes to the Soil Erosion and Sedimentation Control Plan shall be made without approval of the Owner's Representative and the Engineer.

6. No soil, not protected by erosion and sedimentation control measures, can be disturbed at any time.

7. The Contractor shall comply with applicable Federal, State, and local regulations relating to the prevention and abatement of pollution.

8. The Contractor shall be responsible for maintaining all erosion and sediment control devices and shall be required to provide measures to correct problems encountered in the field whether or not the measures are shown on the plan. Measures that include the installation of additional sediment traps, erosion control blankets or reducing the amount of exposed soil may be necessary to comply with the NOI and Part 700 etseq of Title 6, Chapter X of NYCRR

B. Product Data: Submit manufacturer's catalogue cuts, specifications and installation instructions for silt fences, filter fabrics and erosion control blankets.

C. Product Stockpiling: Stockpiles of stabilization measures such as haybales, silt fence, 1½-inch gravel for check dams, filter fabric, and mulch shall be maintained at the site for use in stabilizing disturbed areas in advance of severe weather conditions.

PART 2 - PRODUCTS

2.01 INLET PROTECTION: Filtrexx inlet protection or approved equal.

2.02 DEWATERING PITs: Number and location to be determined by contractor.

2.03 SILT FENCE: Silt fence fabric shall be Mirafi 100X or equal. Wood posts shall be of sound quality hardwood, a minimum 36-inches long and 2-inches square. Metal posts shall be standard T and U section weighing not less than one pound per linear foot. Wire fence backing shall be a minimum 14½ gage with a maximum 6-inch mesh opening and securely attached to fence posts. Posts shall extend a minimum of 16-inches into the ground.

2.04 HAY BALE BARRIERS: Wood posts shall be of sound quality hardwood, a minimum 36-inches long. Metal posts shall be standard T and U section weighing not less than one pound per linear foot.

2.05 FILTER FABRIC: Filter fabric shall be Mirafi 600x.

2.06 TEMPORARY STABILIZATION

A. Establishment of Temporary Grass Cover: Prepare seed bed, scarify if compacted, remove debris and obstacles such as rocks and stumps, and seed within 24 hours. Amend soil, lime soil to pH of 6.0 and fertilize at a rate of 14 pounds per 1,000 square feet with a 5-10-10 or equivalent fertilizer. Work amendments a minimum of 4-inches into soil. If seeding in October/November, seed shall be Certified Aroostook winter rye at 100 pounds per acre, otherwise seed shall be ryegrass (annual or perennial) at 30 pounds per acre.

B. Mulch/RECP: Small grain straw mulch or Type 1 erosion control blankets as specified on drawing SP-5.1. Straw mulch shall be applied at a rate of two tons (100 to 120 bales) per acre. Erosion control blankets shall be BonTerra S2 installed as recommended by manufacturer.

C. Install Temporary Stabilization within 24-hours after the end of construction activities in an area unless there is snow cover or construction activities will resume within seven days.

D. Tackifier: When covering between October and April, cover exposed soils with hydroseed and tackifier with the following application rates:

1.	Slopes less than 3 Vert.:12 Horiz.	75 lbs/ac
2.	Slopes between 3 Vert.:1 Horiz. and 2 Vert.:1 Horiz.	100 lbs/ac
3.	Slopes greater than 2 Vert.:1 Horiz.	150 lbs/ac

Acceptable product: Conwed Fibers Con-Tack AT Tackifier as manufactured by Profile Products, LLC (800) 366-1180

PART 3 - EXECUTION

3.01 **GENERAL:** Install and remove measures as required. The measures shall be maintained until permanent protection of the contributing watershed is approved by the Owner's Representative. All storm drainage outlets that have been silted due to the work will be cleaned, as required.

3.02 **INSPECTIONS:** Inspect and report measures daily and within 24-hours of the end of a 0.5 inch or greater storm event. All inspections are to be made by a NYS trained and certified contractor. Stabilized areas will be inspected monthly until the entire site is stabilized. Maintain SWPPP log book on-site with daily reports for the Owner demonstrating compliance with these specifications and the project's SWPPP.

3.03 **MAINTENANCE:** Maintenance and deficiencies shall be completed within two calendar days of determining its need.

3.04 **PAVEMENT:** Provide temporary pavement when adjacent to traffic lanes and when directed by the Engineer.

3.05 **VEHICLE WASHDOWN:** Provide vehicle washdown area and/or wheel wash station at all construction entrances to prevent tracking of soil and other debris onto adjoining public and private roads. Maintain as necessary during project earthwork operations.

END OF SECTION 31 17 50

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SECTION 31 20 00

EARTHWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related sections include but are not limited to:
1. Division 02 Section 024120 Site Demolition
2. Division 31 Section 311500 Site Preparation
3. Division 31 Section 311750 Erosion and Sediment Control

C. Any conflict in requirements between the Drawings, Specifications, Geotechnical Report, or other design documents should be interpreted in favor of the most restrictive requirement unless otherwise directed by the Engineer.

1.02 SUMMARY

A. Section Includes:
1. Definition of excavation, fill and backfill materials.
2. The preparation and dewatering requirements for open excavations and/or structures.
3. General excavation requirements.
4. Excavation requirements for buildings and structures.
5. Excavation requirements for preparing subgrades for walks and pavements.
6. Excavation requirements for utility trenches.
7. Excavation of landscaped areas.
8. Subgrade inspection requirements.
9. General backfill requirements.
10. Backfill requirements for utility trenches.
11. Fill material requirements.
12. Soil moisture control requirements.
13. Compaction requirements of backfills and fill material.
14. Bedding course placement under slabs-on-grade, walks and other structures.
15. Subbase course placement under asphaltic concrete pavements.
16. Drainage course for porous pavement and underdrain systems.
17. Subsurface drainage.
18. Field quality control of subgrade preparation, material backfill and compaction testing.
19. Protection of excavated and graded areas.
20. Storage of soil materials.
21. Unauthorized excavation.
22. Removal of excess and unsuitable material from the site.

1.03 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
1. Initial Backfill: Backfill placed beneath, beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench to the top of the proposed subgrade as shown and detailed on the plans.

B. Structural Fill: Fill material placed under structures after removal of unsuitable bearing materials. Material shall be 3/4 inch, clean aggregate or other material as approved by the project's geotechnical engineer.

C. Subbase Course: Aggregate layer placed between the existing subgrade and hot-mix asphalt paving.

D. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe and in other open excavated areas to support new curbing, walks, concrete stairs, slabs-on-grade, manholes or other structures. The bedding material shall also be used to backfill trenches to the depths and/or limits detailed on the plans. Sand bedding material shall be used in place of the aggregate material specified where required by the local utility, Owner's representative or Project Engineer.

E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill, or soil from on-site sources meeting the specifications for fill material and determined suitable for on-site use.

F. Drainage Course: Aggregate layer supporting the collection and transporting of water.

G. Earth Excavation: Defined to include removal, and if required proper disposal off-site, of the following:
1. Soil and all other materials encountered of any name and nature that are not classified as rock excavation or unauthorized excavation.
2. Hardpan, loose or decomposed bedrock or other such material that may require intermittent drilling and wedging to increase production or facilitate handling of the material with equipment normally used in the particular excavation operation.

H. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as shown on the contract drawings. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

I. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

J. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owner, Construction Manager, or Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation. Remedial work may include, but not be limited to, replacement of the unauthorized excavation by backfilling and compacting as specified for authorized excavations of the same classification, unless otherwise directed by the Owner's Representatives.

K. Fill: Soil materials used to raise existing grades.

L. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cubic yard for bulk excavation or 3/4 cubic yard for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.

1) Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf

and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.

2) Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

M. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd**.** or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586

N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, inlets, catch basins, manholes, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

O. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below the subbase or bedding course, drainage or reservoir course, or topsoil materials.

P. Recycled Material: The use of recycled material from any off-site source will not be permitted.

Q. Utilities: On-site underground pipes, conduits, ducts, tunnels, and cables, as well as underground services within buildings.

1.04 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
1. Geotextiles.
2. Controlled Low Strength Material (CLSM).
3. Warning tapes.
4. Imported borrow fill and aggregate

B. Samples for Verification: For the following products, in sizes indicated below:
1. Geotextile: 12-inches by 12-inches.
2. Warning Tape: 12-inches long; of each color.
3. Earthwork, borrow fill, aggregate materials; 5 gallon pail containing a representative sample plus a sealed quart plastic bag containing a representative moisture sample of material passing the No. 4 sieve.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 1557.

E. Pre-Excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.05 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.06 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth moving operations.

C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures are in place.

D. Do not commence earth moving operations until plant-protection measures are in place.

E. Do not commence earth moving operations until all subsurface utilities have been located and marked in the field.

F. The following practices are prohibited within areas not identified as work zones shown on the approved Construction Plan:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Erection of sheds or structures.
   4. Impoundment of water.
   5. Excavation or other digging unless otherwise indicated.
   6. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Subsurface Information:

   1. The Owner makes no predictions or representations regarding the character or extent of soil, rock or other subsurface condition to be encountered during the work. The Contractor shall make his own deductions on the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated and/or anticipated by him. Borings and other exploratory operations may be performed by the Contractor, at the Contractor's option and following the Owner's approval. No change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
   2. A Geotechnical report has been prepared and included in the Project Manual.
   3. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations resulting from the subsurface conditions.
   4. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the confirmation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed preliminary to and during the execution of the work; the general and local conditions, water levels and all other matters which can in any way affect the work.

5. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining properties and the proposed sequence of construction.
6. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all New York State and Federal regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, and SP according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3-inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups SM, GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
   2. Unsatisfactory materials also include materials below structures and/or foundations determined by the Owner's Representatives to be unsatisfactory bearing materials.

D. Subbase Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; NYSDOT Type 1. The use of recycled material from any off-site source will not be permitted and recycled material from onsite demolition may not be used without written authorization from the owner.

E. Structural Fill: Naturally or artificially, well graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1½ -inch sieve and not more than 12 percent passing a No. 200 sieve. This material must be approved by the Owner's Representatives.

F. Bedding Course: ~~Naturally or artificially graded mixture of natural or crushed gravel or crushed stone; ASTM D 2940; except with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 8 sieve.~~ Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Trap Rock: Narrowly graded mixture of washed crushed stone ASTM D 448; coarse-aggregate grading Size 1; with 100 percent passing a 4-inch sieve and 0 to 15 percent passing a 1½-inch sieve.

H. Sand: ASTM C 33; fine aggregate.

I. Topsoil and other Planting Media: See Division 32 Section 329000 Planting Media Preparation and Placement.

J. CLSM high slump mixture of Portland cement, fly ash and fine aggregate formulated, licensed and marked K-Krete or equal.

1. Provide mixture with a 28 day compressive strength of 200 psi with no measureable shrinkage or surface settlement.

2.02 GEOTEXTILES

A. Subsurface Drainage Geotextile: Filter fabric, manufactured for subsurface drainage applications, should meet the following minimum requirements as described in the "Subsurface Investigation and Analysis Report":
   1. Minimum Permittivity (ASTM D4991) = 0.2 sec^{-1}
   2. Maximum AOS (ASTM D4751) = 0.25 mm

B. Acceptable Products:
   1. Mirafi 140N by Mirafi, Inc. or approved equal.

2.03 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6-inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30-inches deep; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross

sectioned by the Owner's Representatives. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
   a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
2. Rock excavation includes removal and disposal of rock if material cannot be reused on-site or found to be surplus excavated material. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. 12-inches outside of minimum required dimensions of concrete cast against grade.
   b. 12-inches beneath bottom of concrete slabs-on-grade.
   c. 12-inches beneath pipe in trenches, and the greater of 24-inches wider than pipe or 30-inches wide.

3.04 EXCAVATION FOR BUILDINGS AND STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1-inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavation for Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1-inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.05 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.06 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12-inches higher than top of pipe or conduit unless otherwise indicated.
1. Clearance: 12-inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 6-inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

3.07 EXCAVATION OF AREAS TO BE LANDSCAPED

A. Excavate existing soil to the depths required to prepare the subgrade to receive topsoil, amended soil, drainage course material or other material as detailed on the plans. Loosen subgrade using rototillers to a minimum depth of 6-inches. Remove all stones larger than 1-inch in any

dimension and all sticks, roots, rubbish, and other extraneous matter within the planted areas and legally dispose of them off the Owner's property.

B. If underground utilities, rock or groundwater conditions are encountered at an elevation at or above the elevation of the required subgrade the Contractor shall notify the owner's representative immediately.

3.08 SUBGRADE INSPECTION

A. Notify the Owners Representative when excavations have reached required subgrade.

B. If the Owner's representative determines that unsatisfactory soil is present, continue excavation and replace with structural fill or other backfill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 30 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
      a. A complete proof roll is considered to consist of 2 passes in each proof roll direction with a pass equal to full coverage of the subgrade with a minimum of one double wheel width.
   2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner's Representative, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's Representative, without additional compensation.

3.09 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, sub-drainage.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Place and compact initial backfill of satisfactory soil, free of particles larger than 1-inch in any dimension, to a height of 12-inches over the pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Place and compact final backfill of satisfactory soil or Control Density Backfill Material to final subgrade elevation.

F. Install warning tape directly above utilities, 12-inches below finished grade, except 6-inches below subgrade under pavements and slabs.

G. All trenches located within Public Rights of Way (streets and sidewalks) shall be backfilled with Controlled Density Backfill Material above the initial backfill subgrade.

3.11 FILL MATERIAL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, gravel material.
   3. Under steps and ramps, use structural fill.
   4. Under building slabs, use structural fill.

C. Place fill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF BACKFILLS AND FILL MATERIAL

A. Place backfill and fill materials in layers not more than 12-inches in loose depth for material compacted by heavy compaction equipment, and not more than 4-inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
   1. Under structures, steps, and pavements, scarify and re-compact top 12-inches of existing subgrade and each layer of backfill or fill material at 95 percent.
   2. Under walkways, scarify and re-compact top 6-inches below subgrade and compact each layer of backfill or fill material at 95 percent.
   3. Under turf or unpaved areas, scarify and re-compact top 6-inches below subgrade and compact each layer of backfill or fill material at 90 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.14 SUBBASE COURSE UNDER ASPHALTIC CONCRETE PAVEMENTS

A. Place subbase course on existing and/or compacted subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements as follows:
1. Place subbase course material over subgrade and under hot-mix asphalt pavement.
2. Shape subbase course to required crown elevations and cross-slope grades.
3. Place subbase course 12-inches or less in compacted thickness in a single layer.
4. Place subbase course that exceeds 12-inches in compacted thickness in layers of equal thickness, with no compacted layer more than 12-inches thick or less than 3-inches thick.
5. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.15 BEDDING COURSE UNDER SLABS-ON-GRADE, WALKS AND MISC. STRUCTURES

A. Place bedding course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact bedding course under slabs-on-grade, walks and other structures as follows:
1. Place bedding course 12-inches or less in compacted thickness in a single layer.
2. Place bedding course that exceeds 12-inches in compacted thickness in layers of equal thickness, with no compacted layer more than 12-inches thick or less than 3-inches thick.
3. Compact each layer of bedding course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile, drainage course filter material and sub-drainage pipe in accordance with the details shown on the plans.
1. Surround drain pipe with 6-inches minimum drainage course material (as specified herein) or as detailed on plans.

3.17 FIELD QUALITY CONTROL

A. Special Inspections: engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938 as applicable. The location of each compaction test shall be recorded on a site plan and labeled in the same manner as the corresponding test report. Upon completion of the project all test reports and location maps shall be submitted to the owner. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 1,000 square feet or less of paved area or building slab, but in no case fewer than three tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
3. Compaction tests of the base material shall be completed such that no precipitation occurs between the compaction test and the paving.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

D. Soil Material Testing: A representative sample as required by the owner's representatives from a truck load of imported material shall be tested for conformance to the specifications.

E. Imported Material that does not meet the specified gradation shall be removed from the site and replaced with conforming material.

3.18 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Turf Areas, Planting Areas or other Unpaved Areas: Plus or minus 1-inch of the proposed top of subgrade elevation to receive topsoil, planting and/or amended soil mix, drainage course material or other material to the depths detailed on the plans.
2. Concrete Pavements, Walks and other structures: Less than 1/2 inch of the proposed bottom of the bedding course as detailed on the plans.
3. Asphalt Pavements: Less than 1/2 inch of the proposed bottom of the subbase course as detailed on the plans.

3.19 PROTECTION OF THE WORK AREAS

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Owners Representative; reshape and re-compact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 STORAGE OF SOIL MATERIALS

A. Stockpile borrows soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.21 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by the Owner's Representatives.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Owner's Representative.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Unless directed otherwise, transport surplus satisfactory and unsatisfactory soil off Owner's property.
   1. Remove waste materials, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes construction dewatering.

B. Related Sections:

1. Division 01 Section “Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading, and for site utilities.
3. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

1.03 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Remove dewatering system when no longer required for construction.

1.04 SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing NYSDEC and Westchester County Department of Public Works and Transportation.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Construction Manager and Owner's representatives no fewer than two days in advance of proposed interruption of utility.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: Engage a qualified New York State licensed land surveyor to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing during dewatering operations.

3.02 INSTALLATION

A. Install dewatering system utilizing a pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

2. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 31 23 19

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SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections:
   1. Division 01 Section Temporary Facilities and Controls – for temporary utilities and support facilities.
   2. Division 31 Section Dewatering – for dewatering system for excavations.

1.02 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.03 PERFORMANCE REQUIREMENTS

A. Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
   1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
   4. Monitor vibrations, settlements, and movements.

1.04 SUBMITTALS

A. Shop Drawings: For excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 QUALITY ASSURANCE

A. Pre-Installation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
      a. Existing utilities and subsurface conditions.
      b. Proposed excavations.
      c. Proposed equipment.
      d. Monitoring of excavation support and protection system.
      e. Working area location and stability.
      f. Abandonment or removal of excavation support and protection system.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   1. Notify Construction Manager and Owner no fewer than three (3) days in advance of proposed interruption of utility.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 3 inches.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.02 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular

intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

3.03 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
   1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
   2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section 312000 Earthwork.
   3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00

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SPECIFICATIONS GROUP

Site and Infrastructure Subgroup

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 05 23	CONCRETE FOR EXTERIOR IMPROVEMENTS
32 10 00	SITE CARPENTRY
32 12 12	EXTERIOR FOUNTAIN
32 12 16	ASPHALT CONCRETE PAVING
32 12 17	POROUS ASPHALT CONCRETE PAVING
32 13 13	CEMENT CONCRETE PAVING
32 13 73	PAVEMENT JOINT SEALANTS
32 14 13	PRECAST CONCRETE UNIT PAVING
32 16 00	CONCRETE CURB
32 32 23	SEGMENTAL RETAINING WALLS
32 33 00	SITE FURNISHINGS
32 50 00	METAL FABRICATIONS
32 90 00	PLANTING

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SECTION 32 05 23

CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following:

1. Concrete pavement
2. Colored concrete pavement
3. Reinforced concrete walls
4. Concrete foundations and pavement base courses

B. Related sections include the following:

1. Section “Quality Control” for controlled inspection testing associated with this Section.
2. Section 32 14 13 – “Precast Concrete Unit Paving”
3. Section 32 33 00 – “Site Furnishings”

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete pavement and concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of 5 years of successful in-service performance.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

G. Testing and control for concrete:
1. The Contractor shall furnish copies of test results from the concrete supplier as listed below. Tests shall be at the expense of the concrete supplier by an independent testing laboratory and shall have been made within the past six months.
    1) Aggregate standard gradation and physical properties meeting these specifications.
    2) Aggregate potential alkali reactivity data as specified in ASTM C33.
    3) Historical compressive strength data of the concrete proposed to satisfy the performance requirements specified herein.

2. Tests occasioned by changes of materials or mix proportions shall be at the expense of the Contractor.

3. Tests for slump will be made at place of deposit and in accordance with ASTM C143 by the Owner. Tests shall be made for each concrete load at point of discharge as approved by and in the presence of the Engineer or his representative.

4. The Owner will make, in accordance with ASTM C31, four test cylinders for each 50 cu. yds. or one day's pour, whichever is less. Tests shall be made in accordance with method of "Test for Compressive Strength of Molded Concrete Cylinders, ASTM C39". One cylinder shall be tested at 7 days, two cylinders tested at 28 days. The fourth cylinder shall be used for additional tests as necessary, being retained at the laboratory for necessary period as approved by the Engineer.

5. Tests for air content shall be made in accordance with ASTM, C94, using ASTM C231 method of test. Intermediate Chase Meter tests shall be made on each load of concrete or as considered necessary by the Engineer’s Results shall be sent to the Engineer's office within three days after the tests are made, except notifications at once when tests show low test results. Submit test results to Owner within 24 hours of test. The Owner reserves the right to verify water to cement ratio compliance with the microwave test method.

6. Additional Tests necessary to resolve disputes will be made by an independent testing laboratory designated by the Engineer. If work is found to be deficient, testing cost shall be paid by the Contractor. If work is satisfactory, testing cost for additional tests will be paid by the Owner.

7. Provide certification that plant, equipment and materials to be used in concrete comply with the requirements of this specification

8. Provide certification (i.e., signed letter) that mix proportions selected will produce concrete of specified quality, yield and strength, and that mix design is adjusted to pavement alkali aggregate reactivity problems

2. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, and standard of workmanship for each type of paving and concrete indicated.

1. Build a minimum of 10’x10’ mock-up of each color and finish of concrete.

2. Notify Architect seven days in advance of dates and times when mockups will be constructed.

3. Obtain Architect's approval of mockups before starting construction.

4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.

5. Demolish and remove approved mockups from the site when directed by the Architect.

3. Pre-Installation Conference: Conduct conference at Project site to comply with requirements in Section "Project Management and Coordination.”

1. Before submitting design mixes, review concrete pavement mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete pavement to attend, including the following:
   1) Contractor's superintendent
   2) Independent testing agency responsible for concrete design mixes
   3) Ready-mix concrete producer
   4) Concrete subcontractor

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples:

1. 8”x8” sample showing finish and color for concrete pavement

D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials
2. Aggregates, conforming to ASTM C33, involving reactivity test results
3. Steel reinforcement and reinforcement accessories
4. Admixtures
5. Curing compounds
6. Applied finish materials
7. Bonding agent or adhesive
8. Joint Fillers and sealants

1.5 DELIVERY, STORAGE & HANDLING

A. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

1.6 JOB CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 feet (30.5 m) or less

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces

2.2 STEEL REINFORCEMENT

A. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

B. Epoxy-Coated Reinforcement Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars.

C. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A coated, plain steel.

D. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain steel bars.

E. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Portland Cement: ASTM C 150, Type A, moderate sulfite Resistant.

1. Fly Ash: ASTM C 618, Class F or C. Fly Ash in concrete shall be between 15 and 20 percent of the total cementitious material by weight.

2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Coarse Aggregate: Shall be hard, durable, uncoated crushed stone or gravel conforming to ASTM C 33 (class 4S), uniformly graded, from a single source. Coarse and fine aggregates shall be NYS DOT Approved and shall be limestone or shall not be designated as having ASR or AAR potential.

1. Do not use fine or coarse aggregates containing substances that cause spalling.

D. Fine aggregate shall be sand, clean hard durable, uncoated grains free from silt, loam and clay, to meet ASTM C33.

E. Water: ASTM C 94.

2.4 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.

B. Air-Entraining Admixture: ASTM C 260.

C. The Testing Laboratory employed by the contractor shall be charged with full control of the use of

2.5 CURING AND SEALING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sy(305 g/sm) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.7 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.

C. Proportion mixes to provide concrete with the following properties:
1. Compressive Strength (28 Days): 3500 psi, 4000 psi and 5000 psi.as indicated on drawings.

2.8 Concrete Mixing

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2.9 COLORED CEMENT CONCRETE

A. Colored concrete shall be integrally colored Chromix Admixtures for Color-Conditioned Concrete including Chromix P Admixtures and Chromix G, by Sika Corporation.

1. Admixture shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are lime-proof and ultra-violet resistant.

2. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494 and ASSHTO M194.

3. Raw pigments are not an equivalent and may not be substituted.

B. Curing Compound for Integrally Colored Concrete: Curing compound shall comply with ASTM C309 and be of same manufacturer as colored admixture, for use with integrally colored concrete.

1. Exterior Integrally Colored Concrete: LITHOCHROME® Colorwax™; Sika Corporation.. Use to cure exterior flatwork that will be allowed to cure naturally with only occasional maintenance.

C. Colored concrete admixture color shall be as indicated on the drawings. Cement color shall be gray. Sand shall be locally available natural sand. Curing compound shall match integrally colored concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, curing compounds, and sealers.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevation. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.

C. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

D. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortion. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap to adjacent mats.

3.4 JOINTS

A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.

1. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.

2. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints as indicated.

2. Terminate joint filler less than 1/4 inch (6 mm) or more than 1/2 inch (12 mm) below finished surface if joint sealant is indicated.

3. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

4. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed caps. Remove protective cap after concrete has been placed on both sides of joint.

D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicate Construct contraction joints for a depth equal to at least one-third of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

1. Radius: 3/8 inch (10 mm)

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery, at Project site, or during placement.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations.

J. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

K. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

L. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 CONCRETE FINISHING

A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Floating: Begin the floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true plane. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. After concrete surface has been floated, provide Medium-to-Fine-Textured Broom Finish: draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperature Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sft. x h (1 kg/sm x h) before and during finishing operation Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

1. Water

2. Continuous water-fog spray

3. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.8 TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch (6 mm)

2. Thickness: Plus 3/8 inch (9 mm), minus 1/4 inch (6 mm)

3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/4 inch (6 mm)

4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm)

5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm)

6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm)

7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm)

8. Joint Spacing: 3 inches (75 mm)

9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus

10. Joint Width: Plus 1/8 inch (3 mm), no minus

3.9 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements. All testing will be performed by the Contractor and inspected by the Q/C Engineer. All testing and inspections for this Section will be paid under the allowance item for Controlled Inspection Testing.

B. Testing Services: Testing shall be performed according to the following requirements:

1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.

2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.

3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.

5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.

6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. y(4 cu. m), but less than 25 cu. y(19 cu. m), plus one set for each additional 50 cu. y(38 cu. m). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.

7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

8. When total quantity of a given class of concrete is less than 50 cu. y(38 cu. m), Architect may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

10. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).

C. Test results shall be reported in writing to the Owner's Representative, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Non-Destructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Construction Manager but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by the Construction Manager. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by the Owner's Representative when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Do not permit construction traffic on concrete pavement. Exclude all traffic from pavement for at least 14 days after placement. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 05 23

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SECTION 32 10 00

SITE CARPENTRY

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. Wood Decking

B. Related Sections include the following:

1. Metal Fabrications: Section 055000

2. Cement and Concrete for Exterior Improvements: Section 320523

1.3 QUALITY ASSURANCE

A. Utilize an Installer having successfully completed installation work similar in design, material, and extent indicated on this project.

B. Contractor shall have a minimum of 5 years experience completing similar work.

C. Installer shall submit a sample of each component which will be used in the project.

D. Lumber: Comply with American Softwood Lumber Standard PS-20-70. Provide lumber species complying with grading rules of following associations.

1. Southern Yellow Pine: Yellow Pine: Standard Grading Rules for Southern Pine Lumber, published by Southern Pine Inspection Bureau (SPIB).
   a. Douglas Fir: Western Lumber Grading Rules, published by Western Wood Products Association (WWPA), or Standard Grading Rules for West Coast Lumber, Number 16, published by West Coast Lumber Inspection Bureau (WCLIB).

2. Design and detailing of wood framing connections: Comply with National Forest Products Association (NFPA) National Design Specifications for Wood Construction.

3. Provide and install fasteners and nails complying with NFPA Recommended Nailing Schedule of the Manual for House Framing.

4. Wood treatment: Comply with American Wood Preservers Association (AWPA) standards for wood preservative treatment scheduled.

5. Provide each piece of plywood and lumber factory grade-marked.

1.4 SUBMITTALS

A. Shop drawings, manufacturer's data, and cut sheets, shall be provided for all items covered under this section.

B. Shop drawings and/or manufacturer's product literature and data must include the following:

1. Shop drawings for all structures shall include complete plan and elevation layout illustrating height and sizes of all elements, locations and sizes of posts, rails, braces and anchorage. Provide hardware list and erection procedures.

2. A complete list of items and accessories proposed to be furnished. Manufacturer's specifications, catalog cuts and data to demonstrate compliance with these specifications.

3. Manufacturers and model numbers listed under each item of work are to establish a standard of quality. Similar items of other manufacturer's equal in design function and quality will be accepted upon approval by the Landscape Architect. Approval will be based on data submitted by the Contractor and the Contractor will be required to substantiate the equal status of the submission.

C. Samples: Contractor shall provide two (2) 12” long samples for each material, color and finish for all items covered under this section including, but limited to:

1. Structural Lumber Members

2. Wood Decking

D. Wood treatment data: Submit certification from treating plant indicating chemicals and process used and compliance with specified requirements.

E. Submit manufacturer's product data for site carpentry accessory and hardware items.

1.5 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead- time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers packaging with identification labels intact.

D. Unload materials at job site in such a manner that no damage occurs to the product.

E. Storage and Protection: Store materials protected such that they are kept free from mud, dirt, and other foreign materials. Store cleaners and sealers per manufacturer's instructions.

F. Replacement: In the event of damage**,** immediately make all repairs and replacements necessary to the satisfaction of the Landscape Architect, and at no additional cost to the Owner.

1.6 JOB CONDITIONS

A. Coordination: Fit site carpentry work to other work. Scribe and cope as required for accurate fit. Coordinate location of nailers, blocking, and similar supports to allow proper attachment of other work.

B. Layout, cut, fit, and erect framing for rough and finished work. Provide blocking, nailers, and all other site carpentry work. Do cutting work in connection with carpentry work for other trades. Brace, plumb, and level all members in true alignment and rigidly secure in place with sufficient nails, spikes, screws, and bolts as necessary.

C. Layout project work, set stakes, and batter boards.

D. Provide wood framing, nailers, bracing, and supports required to support construction during formative stages. Set wood framing accurately to required lines and levels. Anchor members securely in place.

E. Provide temporary rough carpentry work as indicated or required to construct the work. Maintain temporary items for the life of the work. Remove when no longer needed.

F. Furnish and install miscellaneous hardware in connection with site carpentry work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber:

1. Nominal sizes are indicated. Provide actual size complying with PS-20-70 for moisture content indicated for each use, except where net sizes are indicated by detail dimensions.

2. Provide dressed dimensioned lumber, S4S, kiln-dried or air-dried with maximum 19 % moisture content.

3. Provide Southern Yellow Pine, Douglas Fir or Western lumber WWPA, WCLIB, or WSPFA species meeting No. 1 Grade Standards.

4. Provide all lumber pressure preservative treated with a non CCA preservative, except temporary items removed prior to covering the work with additional materials.

5. Provide Ipe Hardwood lumber for decking.

B. Rough Hardware:

1. Furnish bolts, plates, anchors, hangers, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to structures.

2. Provide manufactured or fabricated items of sizes, shapes, and dimensions required

3. Bolts: ASTM A307, provide with double washers.

4. Steel: ASTM A36

5. Fasteners and anchorages: Provide size, type, material, and finish required for nails, screws, bolts, nuts, washers, and anchoring devices. Provide stainless steel or painted hot-dip galvanized finish fasteners and anchorages size and type to suit application.

6. Provide toggle bolt type anchorage of framing to hollow masonry and expansion shield and lag bolt type for anchorage to solid masonry or concrete and bolts or power activated type for anchorage to steel.

7. Metal connectors: Galvanized steel hangers, ties, and anchors. Provide materials sized for full load carrying capacity of supported members.

2.2 WOOD PRESERVATION TREATMENTS

A. Pressure treat lumber and plywood with waterborne preservative for above-ground use in accordance with current American Wood Preservers Association (AWPA) Standard C2. Each piece shall bear American Wood Preservers Bureau (AWPB) quality mark designation LP-2.

B. Air or kiln dry all materials after treatment to maximum 19% moisture content.

2.3 WOOD DECKING

A. Decking: Shall be Ipe in the sizes and configurations as shown on the drawings and as herein

B. Framing: Shall be pressure treated Douglas Fir or Southern Yellow Pine in the sizes and configurations as shown on the drawings and as specified herein.

C. Hardware: Shall be galvanized steel or stainless steel as hereinbefore specified under Section 02550 – Site Improvements.

D. Footings: Shall be diamond pier pin foundations, and/or concrete, as hereinbefore specified under Section 03300.

E. Finish: Shall be determined by Landscape Architect.

PART 3 - EXECUTION

3.1 PREPARATION

A. Obtain measurements and verify dimensions and details before proceeding with carpentry work

3.2 GENERAL INSTALLATION

A. Set wood members accurately to required lines and levels. Provide members of sizes and on spacings shown. Cut, join, and tightly fit framing around other work. Do not splice structural members between supports.

B. Use only treated, sound, thoroughly seasoned materials of longest practical lengths and sizes to minimize joints. Use materials free of warp, unless warp can be easily corrected by anchorage and attachment. Make tight connections between members.

C. Anchor and nail framing to comply with NFPA Recommended Nailing Schedule of the Manual for House Framings.

D. Provide sill plates where wood framing is supported by concrete or masonry. Anchor to embedded bolts.

E. Brush apply 2 coats of an acceptable wood preservative to surfaces of preservative treated lumber which are field cut, dressed, or drilled.

F. All wood components shall be attached using stainless steel fasteners unless otherwise noted.

G. All wood components cut to size shall have freshly cut ends sanded smooth. Any wood pieces with splinter edges, corners, etc. will not be accepted and will need to be replaced at the contractor's expense.

H. All wood decking and other applicable wood components shall be fastened directly through the face of the board using stainless steel screws unless otherwise noted. All screws shall be counter sunk.

I. All wood structures shall be installed true to level, plume, elevation, size, pattern and structure as shown on drawings.

3.3 WOOD DECKING

A. Contractor shall furnish and install wood decking where and as shown on the drawings, securely fastening of and to all structural members

3.4 CLEANING

A. Clean up debris and cuttings on a regular periodic basis.

B. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, tools, and equipment. Repair damage resulting from rough carpentry work.

END OF SECTION 06 10 00

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SECTION 32 12 12

EXTERIOR FOUNTAIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Work of this Section includes all labor, materials, equipment, tools, incidentals, and services necessary to design, engineer, manufacture, supply, and install the fountains with related mechanical and electrical systems complete including all components, hardware, and accessories as indicated on the Contract Drawing and specified herein:

1. Discharge and suction piping systems.
2. Electrical conduit and wiring systems
3. Subterranean Vaults
4. Mechanical and electrical equipment with components and accessories
5. Manufacture of primary fountain equipment and components is a “Basis of Design”
6. Include fountain system testing, adjustment, and operational training for Owner

B. Related Fountain System Work to be Provided by Other Separate Contractors:

1. Concrete and liner fountain basin reservoir
2. Paving systems
3. Earthwork including trench excavation and backfill

1.2 REFERENCE AND STANDARDS

A. General: As Specified in Division 1

B. “Rules Governing and Restricting the Use and Supply of Water”, City of Purchase, NY. Department of Environmental Protection, Bureau of Water and Sewer Operations, Division of Water Connections and Permits.

C. Other Standards and References:

1. American Society for Testing and Materials (ASTM)
2. American Water Works Association (AWWAA)
3. American Public Works Association (APWA)

4. American National Standards Institute, Inc. (ANSI)

5. National Fire Protection Association (NFPA)

6. Underwriters Laboratories, Inc. (UL)

7. National Sanitation Foundation (NSF)

8. Department of Health (DOH)

9. National Electric Code (NEC)

10. American Society of Mechanical Engineers (ASME)

11. American Society of Sanitary Engineering (ASSE)

12. Commercial Standards (CS)

13. National Electrical Manufacturer's Association (NEMA)

14. Uniform Building Code (UBC)

15. Institute of Electrical and Electronic Engineers (IEEE)

16. Insulated Power Cable Engineers Association (IPCEA)

17. International Plumbing Code (IPC)

D. All work shall conform to the latest edition of the National Building Code and/or International Plumbing Code.

1.3 SYSTEM REQUIREMENTS

A. Design Requirements:

1. The fountains described in this Section shall be a fully automated, self- contained type stationary feature.

2. The work of this Section shall include design of equipment items for fabrication and installation of fountain equipment and components to suit Project requirements as approved by Owner. See Division 1 for additional provisions related to delegated design by Owner's Engineer.

B. Performance Requirements:

1. The Entry Feature consists of (6) 1-1/2" geyser nozzles, each of which will have a 15' display height. Each geyser nozzle will have an 18W RGB LED light at the base of the display. Additionally, (9) 4' linear white LED lights shall be located at the base of the concrete sign wall. The minimum pumping rate for this feature will be 240 g.p.m.

2. The Memory Garden feature consists of (3) custom stainless steel discharge scuppers. Each scupper will have a 9W RGB LED light located on the floor of the fountain pointing upward towards the water falling from the scuppers. The minimum pumping rate for this feature will be 60 g.p.m.

1.4 SUBMITTALS

A. General: Refer to and comply with Division 1 Section, for procedures and additional submittal criteria

B. Installer Qualifications: Comply with Article "Quality Assurance" herein. Submit fountain system installer qualifications including resume and system identification of previous work experience on fountain systems of type indicated for Project and the following work:

1. Plumbing work

2. Electrical Work

3. Concrete and Waterproofing Work

C. Product Data:

1. Submit manufacturers' data for all equipment and individual components listed in "Part 2 – Products"

2. Submit a comprehensive electrical package to include a power diagram, logic diagram, process and instrumentation diagram, panel layout, component schedule, and cut sheets on all individual components in the control panel. The contractor shall furnish evidence that the building department has been contacted to assure local compliance and that any exceptions to local requirements or the National Electric Code have been addressed.

3. Submit for other items and materials of system not indicated in this Section including for items of conduit, wiring, electrical devices, piping and fittings, sealants and/or seals to confirm compatibility and conformance to Project wide requirements.

D. Shop Drawings: A concise plan, details, and section(s) shall accompany the submittal data on all components to assure compliance with the intended design as specified and shown on the Contract Drawings.

1. Include equipment and material handling instructions and interfacing requirements and coordination notes with other trades and contractors.

2. If family product data sheets are submitted for approval, cross out all items not appropriate and highlight the selections for the components to be submitted, include all options.

E. Samples for Verification: Submit for surface exposed elements of system as requested by Architect and highlight only the information that is pertinent.

F. Quality Control Submittals:

1. Test Reports: Fountain manufacturer's test report must be included in the control panel information package. This report shall include results of the test on both motors and all lighting circuits and uncommissioning report indicating proper operation.

2. Field Reports: The manufacturer shall provide a field test report in the controls package. This report, which includes information on the field voltage, current, and resistance at all components, must be filled out by the installing electrical contractor and submitted to the manufacturer and the Architect for approval.

G. Contract Closeout, Operations and Maintenance: Submit manuals pertaining to the operations and maintenance of the fountain system prior to final approval of system installation. The manuals shall include specification sheets, operations and maintenance data, exploded diagrams, replacement part lists, copies of field and test reports, and warranty information. Comply with Division 1.

1.5 QUALITY ASSURANCE

A. General

1. Insofar as possible, all materials and equipment used in the installation of this work shall be of the same brand or manufacturer throughout for each class of material or equipment. The specification has allowed for substitutions; however, the substitution process will be strictly adhered to. If the process is incomplete, or not within the time frame, no substitutions will be considered. Substitutions will not be partially approved. If any item is not approved, the entire submittal will be rejected, not for resubmission. There will be no consideration for alternates, after the bid. Conform to Reference Standards and other Project Manual Sections as applicable.

2. Piping materials shall bear label, stamp, or other markings of specified testing agency.

3. Use numbers of skilled workmen equal to work requirement or occasion. The skilled workman shall be thoroughly trained and experienced in the necessary crafts and shall be completely familiar with the specified requirements and methods needed for proper performance of the work in this Section.

B. Fountain Manufacturer: The fountain equipment described in this section shall be supplied by Delta Fountains, Jacksonville, Florida, (800) 641-6675, Fax: (904) 886-9089 or approved equal. All other fountain manufacturers requesting approval must comply with the requirements listed in the SUBMITTALS section under the Product Data paragraph. All manufacturers' data on individual components listed in PART 2: Products, or pre-approved equals where allowed, shall be submitted to the Landscape Architect and fountain consultant, prior to approval. Manufacturers requesting prior approval shall submit to owner, at least 10 business days prior to the bid date, all data on all individual components listed in PART 2: Products, for review by the owner and fountain consultant. All approvals will be issued in an addendum prior to the bid date.

C. Installer's Qualifications: Plumbing and electrical work for fountain system installation shall be performed by firms with each having at least 5 years of successful commercial fountain installation experience on features similar to that required for the Project.

D. Water feature contractor qualifications:

1. In entering into a contract covering this work, the Contractor accepts the specifications and drawings and guarantees that the work will be performed in accordance with the requirements of the specifications and drawings or such modifications to said specifications and drawings as may be made in the contract documents. The Contractor, in accepting the contract, has verified the design, and will perform such work as is required to achieve the design intent.

2. The contractor shall currently be in the business of constructing custom water features and shall have a continuous 5 year record of no less than 5 successful projects of equal or greater scope.

3. The Contractor further guarantees that the workmanship and material will be of the best quality procurable and that none but experienced workmen, familiar with each particular class of work, will be employed.

4. The Contractor further agrees to hold himself responsible for any defects which may develop in any part of the entire system, including equipment as provided for under this specification, due to faulty workmanship, design or material and to replace, make good, without cost to the Owner, any such faulty parts or construction which may develop at any time within one (1) year from the date of the final acceptance. Any repairs or replacements required because of defects, as outlined in this clause, are to be made promptly and approved in writing by the Landscape Architect.

E. Field Measurements: Verify dimensions with other work on Project which adjoins the equipment item(s) of this Section or to which work of this Section will be a part.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Fountain manufacturer shall adequately package all shipments to protect the material during shipment. Consolidate freight of like items when possible to ensure minimal shipments. All shipments to be freight on board, manufacturer's plant, with fully insured freight allowed to the jobsite.

B. Handling and Unloading: All shipments shall be driver signed and counted to verify that all components listed on the packing slips are included in shipment prior to leaving the manufacturer's premise.

C. Special Handling: Contractor to take necessary precautions in unloading, handling, moving, and storing all shipments, until it is installed in its final position, to protect all components from damage. Contractor to refer to all notes on the shop drawings for any additional instructions on handling fountain equipment.

D. Acceptance at Site: Contractor to schedule and arrange for delivery of all shipments. Contractor is responsible for preparations of all equipment necessary to safely facilitate the unloading of all shipments and moving it to the final location. Freight is F.O.B plant, full freight allowed to jobsite. Contractor to account for all items in each shipment for accuracy before signing for acceptance of shipment. All damages and shortages shall be clearly documented on the Bill of Lading and packing slip before the delivery driver leaves the premises. The

manufacturer shall be promptly notified within 24 hours of any and all documented damages and shortages. By signing the bill of lading, it is mutually agreed that the goods listed are accepted in apparent good order, condition and correct quantity, except as noted, and are in proper condition for transportation according to the applicable regulations of the department of transportation (for truck load shipments). In cases where shipments that are damaged in-transit and are signed for in good condition, it will be the contractor's responsibility to replace those damaged items. All shipments are subject to the manufacture's standard terms and conditions.

E. Storage and Protection: Contractor shall store all components in their original packages and protect all items from damage until final placement occurs. Contractor shall rotate all motor shafts ¼ turn each and every month during storage up to the time of first performance to ensure motor shaft integrity.

1.7 WARRANTY

A. Contractor and installer shall furnish warranty for fountain system installation for a minimum period of one year from date of Substantial Completion of the Contract as specified in Contract Conditions. Contractor shall include provisions of warranty to Owner not otherwise covered by manufacturer. Warranty to include the following:

1. Fountain system to be free of defects of materials and workmanship

2. Fountain system performance to the designated water volumes, heights, patterns, and display features, as outlined in the design requirements in section 1.3(E)(3).

3. Adjustments and/or corrections to warranted equipment shall be made at factory as per standard warranty terms

B. The manufacturer shall warrant all properly installed and maintained fountain equipment (except lamps) as provided in "Part 2 – Products" of this Section, free of defects in material and workmanship for a minimum period of 18 months from shipment or one year from 1st performance, whichever comes first. The fountain manufacturer, at their option, shall replace or repair any materials, components, or workmanship found to be defective within the warranty period when returned to the factory, freight pre-paid. No component may be returned for repair or replacement without an approved return materials authorization.

1. Extended Warranties: Fountain manufacturer shall furnish to Owner any extended warranty that is standard and usually available from item manufacture/supplier for an item of equipment.

1.8 MAINTENANCE AND EXTRA MATERIALS

A. Contractor shall supply chemical treatment materials of sufficient quantity, in addition to materials needed for system testing and adjustment, for use by Owner in maintenance of the system for a period of at least one month after Substantial Completion.

B. Contractor shall supply any other special tools or parts that would be needed for Owner's maintenance of the fountain system.

C. Extra Materials – Contractor to supply 30 day supply of chemicals and media for sand filters

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Mechanical Components: The major mechanical components of the stationary fountain are as follows:

1. DFST-6400, 8’ x 8’ subterranean equipment vault, heavy-duty fiberglass constructed with minimum (13) layers of fiberglass or a minimum of 3/4” thick, one-piece molded construction on bottom shell and lid. Fabricating the bottom shell from fiberglass sheets and caulking the joints will not be acceptable. The vault access hatch shall be 4’ x 4’ landscape access hatch, black gel-coat finish with (2) 60lb, carbon steel lifters mounted on aluminum brackets and bolted to the fiberglass with stainless steel lockable hardware. The hatch shall have a single point stainless steel V-grooved folding T Handle with standard lock cylinder keyed 545 with polished finish and bolted to the hatch with stainless steel fasteners. 6” vents with fiberglass vent caps. All pipe connection fittings to be glassed and sealed to the vault wallshall follow the proprietary 3-step waterproofing method to seal penetrations through the vault structure. This includes the use of a proprietary high performance 2-part methacrylate adhesive, a minimum (3) layers of fiberglass and a waterproof layer of gel coat to seal the entire penetration and prevent hygroscopic water intrusion. The use of bulkhead type fittings will not be accepted. A leveling skid fabricated from steel tubing shall be glassed to the vault bottom allowing for clearance of the sump and for ease of leveling and handling of the vault on site. The vault is to house the feature/filter pump, filtration equipment, chemical feed equipment, UL listed control panel, automatic air compressor, sump pump, exhaust fan, utility light and access ladder and dome lid. The vault is pre- plumbed and pre-wired ready for installation. As shown on the drawings. (Entry Fountain)

2. DFST-3600, 6’ x 6’ subterranean equipment vault, heavy-duty fiberglass constructed with minimum (13) layers of fiberglass or a minimum of 3/4” thick, one-piece molded construction on bottom shell and lid. Fabricating the bottom shell from fiberglass sheets and caulking the joints will not be acceptable. The vault access hatch shall be 4’ x 4’ landscape access hatch, black gel-coat finish with (2) 60lb, carbon steel lifters mounted on aluminum brackets and bolted to the fiberglass with stainless steel lockable hardware. The hatch shall have a single point stainless steel V-grooved folding T Handle with standard lock cylinder keyed 545 with polished finish and bolted to the hatch with stainless steel fasteners. 6” vents with fiberglass vent caps. All pipe connection fittings to be glassed and sealed to the vault wall shall follow the proprietary 3-step waterproofing method to seal penetrations through the vault structure. This includes the use of a proprietary high performance 2-part methacrylate adhesive, a minimum (3) layers of fiberglass and a waterproof layer of gel coat to seal the entire penetration and prevent hygroscopic water intrusion. The use of bulkhead type fittings will not be accepted. A leveling skid fabricated from steel tubing shall be glassed to the vault bottom allowing for clearance of the sump and for ease of leveling and handling of the vault on site. The vault is to house the feature/filter pump, filtration equipment, chemical feed equipment, UL listed control panel, automatic sump pump, exhaust fan, utility light and access ladder and dome lid. The vault is pre-plumbed and pre-wired ready for installation. As shown on the drawings. (Memory Garden)

3. DFVAL-500, exterior/interior equipment vault access ladder shall be aluminum and fiberglass constructed. The access ladder shall be bolted to the inside of the tank using stainless steel hardware and 1/4" x 2" aluminum custom extensions to give the ladder a 15 deg. angle. The Ladder shall is to be installed in accordance to OSHA standards. All fasteners penetrating the vault wall shall follow the proprietary 3-step waterproofing method to seal penetrations through the vault structure. This includes the use of a proprietary high performance 2-part methacrylate adhesive, a minimum (3) layers of fiberglass and a waterproof layer of gel coat to seal the entire penetration and prevent hygroscopic water intrusion. This ladder shall come with Safe-T fall protection ladder extension system. Safe-T extension shall be constructed out of galvanized steel, tool- less installation and shall comply with OSHA standards.

4. DFFP-500, 5 Hp feature pump, the motor shall be 208V, 3 phase full-rated, 1800 R.P.M, standard drip proof motor. The pump shall operate at a minimum of 240 GPM at 45' TDH and shall have flanged 3" suction and 2" discharge connections, and shall be cast iron body, and have a single piece enclosed cast bronze impeller keyed to the shaft. Shaft is heat-treated carbon steel, turned and ground with a renewable bronze sleeve to prevent contact between the shaft and the liquid being pumped. The feature pump is pre-plumbed and pre-wired in equipment vault using min. type 304 stainless steel hardware and including all necessary check valves, isolation/flow control valves, strainers, vacuum switch, and neoprene connectors as shown on the drawings. (Entry Fountain)

5. DFFP-300, 3 Hp, Self-priming full-rated, NSF approved filter pump and fitted 2" FPT connections. The pump shall operate at a minimum of 120 GPM at 60' TDH. Pump is one-piece case constructed with oversized basket strainer, double ring lock design lid for tool free access to removable basket strainer and pump internals. The pump shall have a floating eye seal between the closed impeller and diffuser for maximum efficiency. The motor shall be 208V 3 phase, 3450 R.P.M and have a rust-proof stainless-steel shaft, and permanently lubricated, sealed bearings. Filter pump is pre- plumbed in equipment vault including all necessary check valves, isolation/flow control valves, true union type, as shown on the drawings. (Entry Fountain)

6. DFDAC-100, 1 hp Diffuser air compressor 120v 1 phase, hard wired to fountain controls with air tubing connection and air filter. As shown on the drawings. (Entry Fountain)

7. DFFP-400, 4 Hp, Self-priming, ETL listed full-rated Feature pump and fitted 4" PVC union suction and 4" PVC union discharge connections, one piece plastic case constructed with basket strainer, easy on on/off two piece lid for tool free access to removable basket strainer. The motor shall be 208V, 3 phase, 1750 R.P.M. The pump shall operate at a minimum of 60 GPM at 25' TDH. Feature pump is pre-plumbed and pre-wired in equipment vault including all necessary check valves, isolation/flow control valves, true union type, VFD, gauge panel and vacuum switch. As shown on the drawings. (Memory Garden)

8. DFFP-100, 1 Hp, Self-priming full-rated, NSF approved filter pump and fitted 2" FPT connections. The pump shall operate at a minimum of 40 GPM at 60' TDH. Pump is one-piece case constructed with oversized basket strainer, double ring lock design lid for tool free access to removable basket strainer and pump internals. The pump shall have a floating eye seal between the closed impeller and diffuser for maximum efficiency. The motor shall be 120V 1 phase, 3450 R.P.M and have a rust-proof stainless-steel shaft, and

permanently lubricated, sealed bearings. Filter pump is pre- plumbed in equipment vault including all necessary check valves, isolation/flow control valves, true union type, as shown on the drawings. (Entry Fountain)

9. DFSF-1.92, 19 1/2" Diameter Sand filter with automatic back washing valve, 3.14 square feet of filter surface area and stainless-steel linkage valve system with pressure differential switch for backwash activation, pre-plumbed on tank., The sand filter tank is heavy duty one piece re-enforced fiberglass constructed with UV resistant outer coating surface finish. Sand filter includes easy access, heavy duty closure with integral pressure gauge with air-relief valve, swing away diffuser for easy access to sand and internal parts, all internal parts are threaded for ease of service, maximum operating pressure – 50 p.s.i. The automatic backwash linkage system shall consist of one 3-port bronze body ball valve with electronic actuator, one cast bronze 3-port ball valve and sch. 80 P.V.C. Piping with flanged, clear acrylic sight glass. The valves are connected by type 304 stainless steel single lever linkage with double operator arms and stainless-steel jam nuts and couplings to facilitate manual adjustment of the linkage assembly. The electronic actuator shall be powered by 120V relay outputs from either the P.L.C. (if provided) or relays in the control panel. The backwash initiation shall be configurable for either a set time for backwashing or by use of a pressure differential switch measuring pressure differential from the influent and effluent sensors located on the face piping manifold of the filter. A visual alarm light or dedicated screen on the H.M.I. will be incorporated in the main control panel to alert when the system is in the backwash cycle. Controls for the automatic backwash will switch the position of the 3- port valve when the pressure transmitters read the set pressure differential level. Once the 3-port valve state is switched, the controls will run through a timer-controlled backwash cycle. Once the time set of the cycle is complete, the controls will switch the 3-port valve back returning to normal filtration cycle. Sand filter is pre-plumbed in equipment vault. Filter media is to be provided by contractor. (Memory Garden)

10. DFAV-200, 120VAC NEMA 4X aluminum alloy powder coated electric actuator for 2" plumbing, designed for load requirements of up to 445 in/lbs and be used in either a horizontal or upright position. Outdoor or humid environments actuators must be continuously powered up and the heater is functioning. Actuator has two auxiliary switches, (shared common, rated at 3A 250V Max.), an internal low power heater and mechanical connections that are ISO5211 compliant. The Actuator shall come with an on/off control. Duty cycle on all actuators shall be a minimum of 75% with an ambient temperature operating range of -30˚C to +65˚C (-22˚F to +150˚F). The actuator shall have a minimum of (2) selectable and programmable control signal inputs and also come with a minimum of (2) travel confirmation feedback signal outputs. (Memory Garden)

11. DFSF-7.06, 36 1/2" Diameter Sand filter with automatic back washing valve, 3.14 square feet of filter surface area and stainless-steel linkage valve system with pressure differential switch for backwash activation, pre-plumbed on tank., The sand filter tank is heavy duty one piece re-enforced fiberglass constructed with UV resistant outer coating surface finish. Sand filter includes easy access, heavy duty closure with integral pressure gauge with air-relief valve, swing away diffuser for easy access to sand and internal parts, all internal parts are threaded for ease of service, maximum operating pressure – 50 p.s.i. The automatic backwash linkage system shall consist of one 3-port bronze body ball valve with electronic actuator, one cast bronze 3-port ball valve and sch. 80 P.V.C. Piping with flanged, clear acrylic sight glass. The valves are connected by type 304 stainless steel single lever linkage with double operator arms and stainless steel jam nuts

and couplings to facilitate manual adjustment of the linkage assembly. The electronic actuator shall be powered by 120V relay outputs from either the P.L.C. (if provided) or relays in the control panel.The backwash initiation shall be configurable for either a set time for backwashing or by use of a pressure differential switch measuring pressure differential from the influent and effluent sensors located on the face piping manifold of the filter. A visual alarm light or dedicated screen on the H.M.I. will be incorporated in the main control panel to alert when the system is in the backwash cycle. Controls for the automatic backwash will switch the position of the 3- port valve when the pressure transmitters read the set pressure differential level. Once the 3-port valve state is switched, the controls will run through a timer-controlled backwash cycle. Once the time set of the cycle is complete, the controls will switch the 3-port valve back returning to normal filtration cycle. Sand filter is pre-plumbed in equipment vault. Filter media is to be provided by contractor. (Entry Fountain)

12. DFAV-200, 120VAC NEMA 4X aluminum alloy powder coated electric actuator for 3" plumbing, designed for load requirements of up to 445 in/lbs and be used in either a horizontal or upright position. Outdoor or humid environments actuators must be continuously powered up and the heater is functioning. Actuator has two auxiliary switches, (shared common, rated at 3A 250V Max.), an internal low power heater and mechanical connections that are ISO5211 compliant. The Actuator shall come with an on/off control. Duty cycle on all actuators shall be a minimum of 75% with an ambient temperature operating range of -30˚C to +65˚C (-22˚F to +150˚F). The actuator shall have a minimum of (2) selectable and programmable control signal inputs and also come with a minimum of (2) travel confirmation feedback signal outputs. (Entry Fountain)

13. DFBF-65, 9 lb Automatic erosion type bromine feeder, heavy-duty abs constructed with integral check valve and proportioning valve. Feeder is pre-plumbed in equipment vault.

14. DFWMUA-100, 1" water make-up assembly, type 304, schedule 40 stainless steel constructed with 110V, bronze, slow closing solenoid valve, water hammer arrestor and (3) 1" heavy-duty bronze constructed ball valves. The water make-up assembly is pre-plumbed ready for installation by the contractor. PVC or copper construction is not acceptable. The contractor shall connect in-line on fresh water make-up line and provide back-flow preventer and/or reduced pressure zone, and pressure reducing valve to ensure the incoming line pressure does not exceed 50 P.S.I

15. Hammer Arrestor, ASSE 1010 certified, type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter. (manufacturer and product: Sioux Chief Mfg. Co., Inc., Series 650 and 660)

16. DFEF-150, 1-1/2" N.P.T. cast bronze constructed directional eyeball fitting with 3/4" discharge. PVC constructed is not acceptable

17. DFMD-1200 aeration system diffuser with 13.5" diffuser pad, integral base pad, mounted in De-chlorination vault with stainless steel air manifold. ½" air tubing from equipment vault to tank shall be provided by installing contractor. As shown on the drawings. (Entry Fountain)

18. DFSS-1214-X, 12" X 12" suction sump, constructed of a minimum of 6 layers of heavy duty fiberglass, black gel coat finish on inside, sand coat finish on outside for better

adhesion to concrete, and with integral water-stop flange, stainless steel anti-vortex plate and includes integral schedule 40 PVC, coupling as shown on drawings. Pond area equipment will be equipped with integral stainless steel membrane clamp and fasteners. (Memory Garden)

19. DFAV-1412, 14" X 14" 11 gauge stainless steel anti-vortex plate 11 1/2" X 11 1/2" stainless steel frame and screen sized for 51% open area for 12" sump. Custom screen for habitat areas. The screen will be in a accordion configuration. (Memory Garden)

20. DFSS-1824-X, 18" X 18" suction sump, constructed of a minimum of 6 layers of heavy duty fiberglass, black gel coat finish on inside, sand coat finish on outside for better adhesion to concrete, and with integral water-stop flange, stainless steel anti-vortex plate and includes integral schedule 40 PVC, coupling as shown on drawings. Pond area equipment will be equipped with integral stainless steel membrane clamp and fasteners. All connection fittings are to be glass adhered to the sump wall via a proprietary 3-step waterproofing method to seal penetrations through the vault structure. This includes the use of a proprietary high performance 2-part methacrylate adhesive, a minimum (3) layers of fiberglass and a waterproof layer of gel coat to seal the entire penetration and prevent hygroscopic water intrusion. (Entry Fountain)

21. DFAV-2418, 24" X 24" 11 gauge type 304 stainless steel anti-vortex plate 17 1/2" X 17 1/2' stainless steel frame and screen sized for 51% open area for 18" sump. Custom screen for habitat areas. The screen will be in an accordion configuration. (Entry Fountain)

22. DFSO-300SP, 3" Combination standpipe overflow, cast bronze constructed. 19-1/2" tall, the overflow includes a drain fitting with bronze dome.

23. DFWLS-N, Dual probe water level sensor, cast bronze and stainless steel constructed with integral wave suppression shield, niche mounted. shipped complete for field installation by installing contractor. contractor must place sensor to match operating water level as shown on drawings.

24. DFUL-400LED, 2.5W/24VAC per foot, white linear submersible led light. (Entry Fountain)

25. DFJB-4, 4-Tap underwater junction box, cast bronze constructed with silicone gasket and (1) 3/4" bottom tap and (4) 1/2"side taps with machined brass cord seals and stainless steel hardware. (Entry Fountain)

26. DFJB-8, 8-Tap underwater junction box, cast bronze constructed with silicone gasket and (1) 1" bottom tap and (8) 1/2"side taps with machined brass cord seals and stainless steel hardware.

27. DFGN-150, 1-1/2" N.P.T. Machined cast bronze constructed Geyser nozzle with 3" bell outlet and ¾" machined bore, one piece casting. (Entry Fountain)

28. DFPN-150, 1 1/2" N.P.T. Schedule 40 stainless steel penetration nipple with integral water-stop flange. Red brass or P.V.C. will not be acceptable

29. DFPN-075, 3/4" N.P.T. Schedule 40 stainless steel penetration nipple with integral water-stop flange. Red brass or P.V.C. will not be acceptable

30. DFPN-100, 1" N.P.T. Schedule 40 stainless steel penetration nipple with integral water-stop flange. Red brass or P.V.C. will not be acceptable

31. DFCC-50, 3/4" Machined brass cord seals with neoprene grommet, for water sensor cord

32. DFPC-2123C, two part re-enterable potting compound for application in the junction boxes to provide watertight environment for electrical connections

33. DFUL-3x3W, selectable 9w, 12VAC RGB LED UL Listed, IP68 rated, wet/dry fountain light fixture with adjustable swivel base, certified marine grade 316SS housing with minimum 1/8" thick shell (stamped or spun fixture housing will not be accepted), silicone gasket, tempered glass lens, standard -35 to +25 degree beam angle, 3M UL listed SOW cable (5 wire). Static or Auto preprogrammed color change with connection to power supply, supplied with internal DMX-512 and driver on board. Replaceable LEDs, removable base for wet or dry installation and standard "sparkle matt" face ring with optional mirror polish SS. To be mounted in smooth bore sumps as shown on the drawings. (Memory Garden)

34. DFUL-18/24, 18W/24V RGB LED UL Listed, wet/dry fountain light with adjustable swivel base, cast bronze housing, integral cast bronze rock guard, thermal protection, clear lens, T-4 quartz halogen lamp, DMX compatible, and 150' of type SO cord. (Entry Fountain)

35. DFBFV-XXX, X" butterfly valves for isolation and flow control, lug type, ductile iron bodies, machined 316 stainless steel discs, lever handle for 2" to 6" and gear wheel operator fpr 8" and above, 316 stainless steel stems and EPDM seats. The companion flanges are to be heavy-duty schedule 80 PVC constructed using 304L stainless steel hardware for bolting all valves to the flanges. Sizes as shown on the drawings.

36. DFNC-XXX, single sphere neoprene connector, flat face flanged, with carbon steel, zinc plated flanges, a hard steel wire frame, and precision molded synthetic rubber reinforced with nylon cord. Sizes as shown on the drawings.

37. DFVG-100, Vacuum Switch and gauge panel assembly equipped with (1) weathertight nema 4 enclosed, single pole/double throw switching element, combination vacuum switch with viton o-rings that are suitable for temperatures of 32° - 400° F. Panel also includes (1) ¾" N.P.T., glycerin liquid filled, 304 stainless steel cased pressure gauge with 2.25" dia. face, and (1) ¾" N.P.T., glycerin liquid filled, 304 stainless steel cased vacuum gauge with 2.25" dia. face. Mounted on P.V.C. backboard.

38. DFDPS-100, Differential Pressure Switch and gauge panel assembly equipped with (1) weathertight nema 4 enclosed, single pole/double throw switching element, pressure differential switch with viton o-rings that are suitable for temperatures of 32°- 400° F. Panel is also equipped with influent and effluent ¾" N.P.T. glycerin liquid filled, 304 stainless steel cased pressure gauges with 2.25" dia. face. Mounted on P.V.C. backboard.

39. DFSP-030-EV, Automatic/ UL listed sump pump for equipment vault, 1/3 Hp, 110V1 Phase , 1-1/2" N.P.T. discharge, cast iron motor housing, thermoplastic pump body and strainer, cast iron impeller with 10 vane vortex with pump out vanes on back side, 300 series stainless steel shaft and hardware, Buna-N o-rings, silicone carbide/silicon carbide/Buna-N single mechanical seal, 10ft. cord with plug and Pressure Grommet for sealing and strain relief, single row, ball, oil lubricated upper and lower bearing, including thermal overload protection in motor, vertical float, PVC, Snap Action level control operating at 30' shut off head. Pre-plumbed with 1 ½" Sch. 80 P.V.C. and a 1½" flapper check valve, clear P.V.C. constructed true union type, EPDM O-ring seals and is rated at 150 P.S.I. at 73°F, and pre-wired in equipment vaults

B. Electrical Components: The major components to be included in the control panel and to be incorporated into a fully functional operating fountain system are specified and listed below:

GENERAL

1. The fountain control system shall be designed for 208 Volts, 3 phase, 4 wire service and shall operate (1) 5 Hp feature pump, (1) 1 Hp filter pump, (13) 10W/24VDC led lights, and appurtenances of the fountain. A conductivity type style low water cut off system shall be provided to de-energize the control system during a low water level condition. The water level sensor shall also provide a separate water level control system to increase the water level before the low water cut off alarms in both operating and static environments.

2. NEMA 3R enclosure of galvanized steel construction, primed and phosphatized, finished with ANSI 49 gray baked on enamel, manufactured by Hoffman, equal to HCR series shall be provided. The enclosure shall have collar studs for sub-panel mounting, hasp and staple for padlocking, butterfly type stainless steel draw latches and hinged cover. All Hardware shall be stainless steel.

3. All components shall be mounted to a removable sub-panel. The sub-panel shall be fabricated from 14-gauge steel and shall be finished with baked on white enamel.

4. Service entrance lugs shall be provided, sized for 600 volts, 300-amp minimum. The power distribution block shall have a flammability rating of UL 94V-0, shall be based on NEC table using 75 degrees C wire and shall be equivalent to Square D class 9080.

5. A 600V lightning arrestor shall be provided and connected to the service entrance lugs for 3 phase power and 250V lighting arrestor for single phase power.

6. Motor starters for feature pump shall be IEC rated full voltage, non-reversing with thermal overload relay. Auxiliary contacts shall be provided as required for the specific control functions. Motor starters shall be as manufactured by Square 'D', Allen Bradley or pre-approved equal.

7. All 120 volt equipment shall be protected individually by thermal magnetic circuit breakers with an interrupting rating of 10KAIC @ 240 volt minimum. All circuit breakers shall be calibrated and sealed at the factory and shall be equivalent to Square D, type QOU.

8. The lighting and filter pump contactors shall be 30 amps rated and shall be equivalent to Omron type g72 or equal.

9. The fountain feature / filter pump, and lights shall be controlled by individual 24-hour time clock settings. The time clocks shall be electronic with 24-hour capabilities or shall be integral to the memory module or PLC.

10. The motor and lights shall be controlled by touch screen, designated “Hand - Off - Auto”. In the “Hand” mode, the appropriate motor or set of lights shall be energized until the selection is placed in the “Off” mode. In the “Auto” mode, the appropriate motor shall be controlled by the appropriate time clock.

11. All power wiring shall be color coded using MTW #12 AWG minimum. Control wiring shall be MTW #14 AWG minimum and be numbered/lettered at each end. Wire numbers/letters shall be equivalent to Pass and Seymore “LeGrande”

12. All wiring shall be routed through a wiring duct system to provide wire protection and an organized appearance.

13. Terminals shall be provided for interface with field-installed equipment. The terminal blocks shall be mounted on a 30-degree angle for ease of field connection. Terminals shall be equivalent to Siemens, Allen Bradley, or Square D.

14. All components shall be labeled using a laser-screened Mylar nameplate. The nameplate shall be a laminated two-part system using black letters on a white background on the door and yellow background on the back panel providing protection against fading, pealing, or warping. The labeling system shall be computer controlled to provide logos, post- script type or custom design. The use of engraved plastic type tags is not acceptable.

15. The control system shall have complete drawings/schematics using AutoCAD. The drawing shall have a complete Bill of Materials, front panel view with component locations and electrical schematic. References to the Bill of Materials shall be located for each component.

16. The control system shall be designed and manufactured to meet all state and local codes, Underwriters Laboratories and the National Electric Code (particular attention to article 430 and 680)

17. The entire control system shall bear a UL 508 serialized label “Enclosed Industrial Control Panel”. The use of the UL label “industrial control panel enclosure” without the UL 508 serialized label is not acceptable. Additionally, the control panel shall bear a UL label for “Industrial Control Panel for Permanently Attached Fountains”

18. The low water cutout system shall provide intrinsically safe voltage to the dual probe sensor. The sensor shall provide an input to the PLC to de-energize the pumps and motors. An adjustable time delay shall be provided to prevent nuisance tripping. The HMI shall indicate this alarm as well as provide time delay values for alarm and reset.

19. The water make up system shall provide intrinsically safe voltage to the dual probe sensor. The sensor shall provide an input to the PLC to energize the water make up solenoid. An adjustable time delay shall be provided to prevent nuisance tripping. The

HMI shall indicate this alarm as well as provide time delay values for alarm and reset. The water make-up shall operate on 2 set points for operating and static fill functions.

PROGRAMMABLE LOGIC CONTROLLER FOR MACHINE LOGIC SEQUENCING

A. A programmable logic controller shall control the fountain pumps. The PLC shall be an Allen Bradley Micrologix series, Siemens S71200 series, or pre-approved equivalent

B. Mechanical Features

1. Rugged, compact plastic housing;

2. Easily accessible connection elements and controls

3. Assembly on standard horizontal or vertical;

4. Terminal block as permanent wiring assembly.

C. Design Features

1. Data integrity; the user program is the most important

2. Parameter settings are stored in the internal EEPROM

3. Built-in DC 24V sensor/load power supply for the

4. Direct connection of sensors and actuators;

5. On-board digital input/outputs (CPU with 12 inputs and 12 outputs)

6. Interrupt points;

7. High-speed counters;

8. Easy expandability;

9. 2 high-frequency pulse outputs;

10. EEPROM 16K memory sub-module with real time clock.

11. Battery module for long-term back up.

12. Embedded web page for remote access and monitoring.

D. Functions

1. Fast instruction execution; Instruction execution times of ms or 0.8

2. Extensive instruction set; A large variety of basic operations such as binary logic, result assignment, save, count, time generation, load, transfer, compare, shift, rotate, complement generation, call subroutines, integrated communications instructions and other user-friendly functions such as pulse duration modulation, pulse train function,

arithmetic functions, floating-point arithmetic, PID closed-loop control, jump functions, loop functions and code conversions serve to simplify programming.

3. Counting;

4. Interrupt handling;

5. Edge-controlled interrupts

6. Time-driven interrupts

7. Counter interrupts

8. Communications interrupts.

9. Direct interrogation and driving of inputs and outputs;

10. Password protection;

11. Full access

12. Read only

13. Complete protection.

14. Debugging and diagnostic functions.

15. "Forcing" of inputs and outputs in debugging and diagnostic mode

E. Communications: The built-in PPI (point-to-point interface) provides a range of communications features.

1. If the control panel drawings include remote communication, the avenue of connection through Ethernet via cat5 cable or WIFI will be installed by contractor. The communications capabilities can range from PLC upload/download, to full HMI, VFD, and PLC monitoring and control.

HMI (HUMAN MACHINE INTERFACE) – TOUCHSCREEN

A. The Siemens KTP700 (HMI) basic color touch screen is equipped with a (7") inch STN-display. A resolution of 800 x 480 pixels enables the representation of less complex operating screens. The panel can be operated by a resistive analog touch screen and additionally by 4 freely configurable function keys which – when actuated – provide tactile feedback. Allen Bradly, Square D or pre-approved equivalent.

The HMI shall be programmed to provide a minimum of user accessible screens. There shall be individual screens as applicable:

1. Main (providing access to all screens).

2. Feature Pump (includes Hand Off Auto, Run Status, Strainer/Low Level/Lockout Alarms.

3. Feature Pump Auto Set (includes 2-time clocks for multiple on/off selections)
4. Filter Pump (includes Hand Off Auto, Run Status, Strainer/Low Level/Lockout Alarms.
5. Filter Pump Auto Set (includes 1-time clock for multiple on/off selections).
6. Water Level (includes all level settings/timers, alarms).
7. Backwash (includes all Filter Backwash settings/timers.
8. Lights (includes Hand Off Auto, Color Status, Low Level/Lockout Alarms).
9. Lights Auto Set (includes 2-times clock for multiple on/off selections).
10. Wind (includes High Wind Lockout of Feature Pumps/ Low Wind Reset).
11. Status (a Quick screen shot of the Status of all Fountain Equipment).

PROGRAMMABLE DMX LIGHTING CONTROLLER

A. Pharos model #LPC-1 DMX512 programmable show Controller or pre-approved equivalent.

Performance Features:

- Incoming Power: 9V to 48V DC
- Power Consumption: ~ 4W
- Protocols: DMX512
- Ethernet: Art-Net II, Pathport, sACN
- Operating Temperatures: 0°C to 50°C
- Up to 4 Universes of DMX512
- Programmed using Pharos Designer Software
- Integrated web interface to allow remote management
- Removable SD Card memory card data storage

B. Interface Features

- Isolated DMX512 ports
- RS232/485 serial port/ DMX in
- RJ45 socket for 10/100Base-TX Ethernet
- IEEE 802.3af PoE powered device

- USB-B socket for USB 1.1
- 5-pin DIN socket for MIDI in
- 5-pin DIN socket for MIDI Out

C. The DMX Lighting Controller shall be factory preprogrammed for a minimum of user color selections; RED, GREEN, BLUE. YELLOW, PURPLE, PINK, CHRISTMAS, 4TH OF JULY AND HALLOWEEN. This controller can be programmed for user defined shows by Delta Fountains. Each light shall be programmed individually.

D. JULY, AND HALLOWEEN. This controller

DMX SIGNAL SPLITTER (NOT REQUIRED FOR CS-1000 LIGHTS

Acclaim RDS 600 DMX512 signal splitter for RGB lights or pre-approved equivalent.

Performance Features:

- Operating Voltage 100-240VAC
- Operating Frequency: 50/60 Hz
- Power Consumption: .12A, 14.4W at 120VAC
- Number of DMX Inputs: 1
- Number of DMX Outputs: 6
- Protocols: RDM & DMX-512
- Operating Temperatures: -10°C to 50°C
- Fixture Connectors: 3 pin terminal blocks for lights, 3 conductors for AC input
- Warranty: 3 Year

The splitters shall have individual ports isolating the DMX signal for each light. The DMX Signal to each light shall be separated from all other lights.

2.2 INSTALLATION COMPONENTS

A. Piping Materials:

1. Unless architects specifications indicate otherwise, the suggested minimum piping and fitting standard recommended for this installation is Type 1.

2. All interconnecting piping and associated fittings, supplied by installing Contractor, shall be a minimum of Schedule 80 PVC, NSF-PW rated.

3. All welded PVC fittings above 6" diameter shall be fiberglass reinforced and used only on non-pressurized lines.

4. Use only clear PVC cleaner meeting NSF, UPC, and ASTM standards for cleaning and repairing PVC pipe and fitting surfaces for solvent cementing (IPS Corporation "Weld-On" Type C-65 or equivalent). Follow all directions and instructions appearing on product label.

5. Use only purple PVC primer meeting NSF, UPC, and ASTM #F-656 standards for softening and preparing field pipe and fitting surfaces for solvent cementing (IPS Corporation "Weld-On Type P-70 or equivalent). Follow all directions and instructions appearing on product label.

6. Use only clear or white, heavy bodied, medium setting PVC cement meeting NSF, UPC, and ASTM #D-2564 standards for solvent cementing PVC plastic pipe and fittings (IPS Corporation "Weld-On" Type 711 or equivalent). Follow all directions and instructions on product label.

7. Provide Link Seal for all penetrations in equipment room. All penetrations through outside walls to below grade shall be sealed per building specifications. Using "easy- link seals" is recommended

8. All piping penetrations through structure walls into open areas below pool structure must have the necessary allowances made for settlement

9. Pipe hangers and supports per national plumbing code. All piping in open areas below the pools shall be installed free hanging from the ceiling in the level below with pipe hangers/per specifications and code

10. Reference requirements of other Project Manual Specifications for materials and items not specified herein

11. Thrust Block for Piping Turns

B. Electrical Materials:

1. Rigid conduit shall be corrosion resistant and either galvanized steel or rigid PVC as specified in Part 3 Article "Basic Electrical Methods" herein. Submit Product Data and related specifications on materials to be used. All electrical conduit and conduit fittings between submersible light fixture niches, junction boxes and control panels will be U.L. listed rigid, nonmetallic, PVC NEMA, TC-2 max. 90°C, sunlight resistant for above and below ground use. All conduits shall be protected at all times from possible water ingress. Use only approved primer and PVS glue suitable for joining all PVC conduits and fittings per manufacturer's instructions.

2. All conductors shall be copper with insulation suitable for the particular wiring location as specified in Part 3.4 Article "Basic Electrical Methods" herein. Submit Product Data and related specifications on materials to be used underwater.

3. Reference requirements of other Project Manual Specifications for materials and items not specified herein.

4. All PVC conduit connections underground shall be SCH40 pressure fittings ((FE) male adaptors and couplings). Use color coded primer, pressure fitting PVC glue, and Teflon paste. The use of normal electrical PVC fittings is prohibited.

5. All connections in the pool/fountain shall be made with the assistance of a plumber, using Teflon paste or Teflon tape to eliminate all leaks. Use only tapered (NPT) stainless steel fittings and nipples. The use of galvanized, black, brass or steel piping is prohibited.

6. All conduit connections between dissimilar metals must be made with dielectric fittings, and sealed with dielectric thread compound to prevent galvanic degradation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of existing elevations: Verify all joining elevations prior to laying pipe or setting pipe. Notify Fountain equipment manufacturer, Architect, and or Engineer of all discrepancies before proceeding with the construction of the fountain.

B. Verification of Dimensions: Before proceeding with any work, the contractor shall check and verify all dimensions, sizes, and the like, and shall assume full responsibility for the fitting-in of all materials and equipment to the conditions on site if the Fountain equipment manufacturer, Architect, and or Engineer is not notified in writing and a resolution is not agreed upon.

C. All conflicts relating to any penetration size, dimension, elevation, equipment location, or equipment size or dimension, shall be addressed and resolved with the manufacturer, Architect, and or Engineer of record before the contractor can proceed with the construction of any part of the fountain that may be or become affected by the confliction.

D. Verify Utilities: Contractor shall verify with local authorities where the proper tie into sanitary or storm sewer for overflow and drain.

E. Contractor shall verify matching voltage and phase of main power feed provided to serve the fountain equipment control panel and report all discrepancies in writing to the Fountain Manufacturer, Architect, and Engineer.

3.2 INSTALLATION

A. All equipment furnished under this Section shall be installed in full conformity with the Contract Documents, engineering data, instructions, and recommendations of the manufacturer.

B. Contractor shall obtain all necessary installation permits and inspections

C. Installation of fountain equipment appurtenances shall confirm with provisions of Reference Standards and suit existing conditions on site as approved by Architect

D. Contractor shall insure that installation complies with all applicable national and local codes and project specifications

E. The incoming water supply line pressure must not exceed 50 PSI and is part of the building contract, not the fountain

F. Install horizontal piping 1' below freeze line

G. Excavation, Backfill, and Compaction:

1. Excavating, trenching, and backfilling shall be as specified in the Contract Documents and as noted on the drawings and compaction done in a maximum of 6" lifts

H. All pools/splash pads shall be waterproofed by specified approved means

I. Prior to any finishing materials (I.E. lights, jets, coverplates) being installed, all pools shall be tested for leaks for a minimum of 72 hours and all waterproofing and tile work shall be completed.

J. Refer to mechanical and electrical notes on drawing for further information.

K. Contractor shall field verify all dimensions

L. Consult architectural, structural, mechanical, and electrical drawings for additional details not shown on these drawings

M. When applicable, all weirs shall be installed with an accuracy of "+" or "-"1/16" over the entire weir length. Unless otherwise noted, refer to the architectural drawings for weir details.

N. Contractor shall provide all concrete work as required by all mechanical and electrical fountain equipment requirements including, but not limited to, housekeeping pads, lock-down slabs, and thrust blocks where indicated.

O. Contractor shall provide all utilities such as power supplies, water supplies, and sewer connections under the building contract up to the fountain controls, equipment and/or pool fittings where indicated

P. Contractor shall provide and is responsible for all elevation and X-Y coordinates relating to all fountain equipment including vaults, pool floors, and pumps.

3.3 BASIC PIPING METHODS

A. The Contractor shall verify and confirm all piping layouts, locations, and dimensions shown in these drawings, and insure that the specified locations do not interfere with other equipment, architecture, or construction before installation. All piping shall be installed as shown and as otherwise specified to make a complete, workable, and neat system. All piping shall be cut accurately from dimensions established at the Project site and allowances shall be made for clearance of other devices.

B. All intraconnecting piping and associated fittings, supplied by system manufacturer, shall be a minimum of Schedule 80 PVC, NSF-PW rated. Interconnecting-intraconnecting interface points shall be slip fit, threaded or flanged.

C. All interconnecting piping and associated fittings, supports, and seals shall be per section 2.2 A

D. The Contractor shall not deviate from the pipe sizes shown herein unless prior written approval is obtained from the manufacturer and Architect. When a size is not indicated, the Contractor shall request the pipe size from the fountain manufacturer. In the event that interference with other equipment or architecture requires relocation of pipes or a layout different from that shown herein, the Contractor shall notify the fountain manufacturer immediately for reexamination of hydraulic parameters of the affected sections.

E. Pipe and accessories shall be handled in such a manner to not cause damage. All cutting shall be done in a good workmanlike manner. Before installation, all piping and fittings shall be visually inspected for damage or defects. The interior of the pipe shall be clean during the laying operation. Pipe shall not be laid in water or in the trench when weather conditions are unsuitable for the work. Water shall be kept out of the trench until the pipe is installed. While work is in progress, open ends of the pipe and fittings shall be securely closed so that no trench water, earth, or other foreign matter will enter the piping system or fittings.

F. Perform adequate trenching and backfill operations when installing PVC piping below grade. Trench width should be minimum of "pipe O.D. plus 12 inches" and deep enough to allow piping to be buried a minimum of 12" below the maximum expected frost penetration line to avoid freeze damage. Lay piping in horizontal, parallel, or perpendicular manner. Avoid vertical stacking of pipes. Space minimum of 3" apart on all parallel runs.

G. Use only clean, free-flowing, non-expansive backfill material (naturally rounded ¼" pea gravel, 57 stone, or sand) and backfill in 6" lifts with adequate and complete compaction between lifts to 90% of maximum density per ASTM 1557-70. Compaction to excessive loads shall not be permitted. A second pressure test on the piping system must be made at this time to insure that piping has not been damaged during backfill operations.

H. Concrete "thrust" blocking is recommended at all directional changes (tee's, elbows, etc.), reducer fittings and line terminations (bushings, end caps, plugs, etc.) in fountain display discharge piping 6" and larger.

I. The bearing surface for the concrete thrust blocks, where possible, should be placed against undisturbed soil. Where it is not possible, the fill between bearing surface and undisturbed soil must be compacted to at least 90% standard proctor density. Thrust block shall be a concrete mix not leaner than one part cement, two and one-half sand, and five parts stone. Contractor shall coordinate the location of the thrust block with other work and existing conditions. Work shall be performed in accordance with all applicable codes. For additional information, refer to NFPA 24.

J. The sump pump in the equipment vault shall be connected as immediately as possible after secure placement and shall have a continuous power supply for the duration of the fountain system installation process.

K. Pressure test all piping as specified in Part 3 Article "Field Quality Control" herein.

L. Avoid laying suction piping in a manner that could result in a suction loop before, during, or after backfilling and compaction. Always pitch pipe in a downward direction to avoid a suction loop that will cause air to be permanently trapped, causing loss in performance of the piping system due to increased friction and work load demand.

M. Piping in areas subject to freezing shall be installed at elevation of minimum 1 foot below frost line.

N. Do not install any water lines above the control panel.

O. Any and all costs associated with above are responsibility of installer.

3.4 BASIC ELECTRICAL METHODS

A. The information supplied in the drawings specifies the general requirements of a complete functioning electrical power distribution and control system. The electrical subcontractor shall coordinate all electrical installation activities with the Construction Manager, Contractor, Architect, and (with respect to work Phase) other separate contractors performing work related to fountain installation.

B. All electrical work shall comply with the latest edition of the National Electric Code (NEC), Section 680, published by the National Fire Protection Association; Quincy, Massachusetts. In the event of conflicting requirements between Contract Documents and any local electric code or other governing organizations for this location, the most stringent shall govern and take precedence. In this event, the Architect shall be notified immediately in writing of such conflict.

C. The installation of electrical equipment and wiring in water can produce extreme hazards. It is the responsibility of the installing electrical contractor to consult and comply with all electrical codes and safety regulations prior to installation of electrical equipment. Local codes take precedence over the general notes where discrepancies of conflicts exist.

D. All wiring and conduit shall be sized by the electrical sub-contractor in accordance with the latest edition of the NEC and all electrical codes and regulations. Where wiring and conduit sizes are specified herein, they shall be interpreted as minimum allowable sizes. All conductors shall be copper with insulation suitable for the particular wiring location. Minimum acceptable insulation is type THWN or better, suitable for both dry and wet locations. Conductor insulation shall be moisture resistant, flame-retardant thermoplastic as approved by the NEC. Conductor sizing shall be based on an ambient temperature of 30□C and a conductor temperature rating of 75□C maximum per Article 310 of NEC. All underwater electrical cable shall either be encased in waterproof, sealed PVC conduit or shall be rated for continuous operation in underwater, marine environments.

E. Contractor shall obtain all necessary installation permits and inspections.

F. It is the responsibility of the installing electrical contractor to insure that all electrical equipment is installed and wired, in accordance with Section 2.4 paragraph D above, whether it is called out or not within the contract documents. This is to be done by a qualified, licensed electrician, experienced in fountain system wiring. Delta Fountains assumes no responsibility for liability whatsoever for installations not carried out by a qualified, licensed, electrician in accordance with our shop drawings, and all provisions of the latest edition of NEC in general, Article 680 specifically, and local safety regulations. All Delta Fountains electrical control panels include GFCI's when and where required, when furnished.

G. It is the responsibility of the installing electrical contractor to verify all field dimensions critical to fountain equipment installation and performance and report any discrepancies to Delta Fountains and the engineer upon immediate notice.

H. All conductors shall be run in rigid conduit sized for the number of wires contained within per NEC requirements. Rigid conduit shall be corrosion resistant and either galvanized steel or rigid PVC. When conduit is submerged or in other wet locations, rigid PVC shall be required. Conductor sizing shall be corrected for the number of wires to be run in a single conduit or raceway in accordance with NEC. All conduit locations and routing shall be approved by the Architect before installation.

I. The work includes such necessary material and devices of a minor nature that may not be indicated on the drawings or mentioned in the specifications, but which are necessary for the compliance with codes and for the successful operation of the entire control system. The contractor shall be allowed no extra compensation because of this requirement.

J. All GFCI protected circuits must have a separate neutral. All GFCI breakers have pigtails wired to a neutral bar. A Class 'A' ground fault circuit interrupter (GFCI) must be installed in each branch circuit supplying submersible or underwater fountain equipment. Equipment operating at 15 volts or less must be protected by suitable transformer U.L. Listed and marked for the application.

K. Conduits are drawn for clarity and do not necessarily show exact routing. Contractor shall install conduits with as few changes in direction as jobsite conditions will allow.

L. All electrical equipment must be properly bonded and grounded for safety, per the latest NEC and local code requirements. All bonding lugs shall be provided by installing electrical contractor. Installing contractor shall verify all necessary requirements of local inspector before installing, and notify Delta Fountains of any required deviations from specifications or plans or notes, and resolve all conflicts before installing equipment. Contractor to insure that all bonding codes are complied with for each metal pool equipment component.

M. Submersible/underwater lighting fixtures must be installed for operation at 150 volts or less between conductors. Submersible pumps most operate at 300 volts or less between conductors.

N. Submersible lighting fixtures must be installed with the top of the fixture lens a minimum of 2" below the normal operation water level and must have the lens adequately guarded to prevent contact by any person.

O. All electrical equipment which depends on submersion for safe operation must be protected against overheating by an independent low water cutoff device if the water level drops below normal operating levels, or contain an internal Thermal Bimetallic Ambient compensating overload.

P. Maximum length of exposed submersible cord in the fountain is limited to 9 feet. Cords extending beyond fountain perimeter must be enclosed in approved wiring enclosures.

Q. All submersible lights and pumps must have sufficient cord length to allow removal from the water for re-lamping and normal maintenance. Fixtures can not be permanently embedded in the fountain structure so that the water level must be reduced or the fountain drained for re-lamping, maintenance, or inspection.

R. Submersible equipment must be inherently stable or be securely fastened in place with non-corrosive fasteners suitable for the purpose

S. Underwater junction boxes must be filled with an approved re-enterable electrical potting compound (wax or paraffin is not acceptable) prior to filling pool and after all circuits have been checked to prevent the entry of moisture and must be firmly attached to supports or directly to the fountain surface and bonded as required. All conduit stubbed up through pool floor must be stainless steel. PVC, Red Brass, and Everdur are not acceptable as a conduit support stub for submersible junction boxes. All conduit entries must be completely sealed prior to potting to prevent compound from entering conduit system. After testing, junction boxes shall be sealed with scotch 3M re-enterable compound or other approved filling compound.

T. All underwater junction boxes must be equipped with threaded conduit entries and compression type cord connectors for cord entry. Strain relief connectors serving niche-Mounted underwater lights shall be capable of sealing both the fixture cord and an AWG #8 insulated bonding wire which may be required by some local codes.

U. Pull correct quantity and size conductors, wired with separate ground, through conduit into junction box. Make all splices and connections tight and well insulated. Connect ground wire to ground lug in junction box, or other suitable grounding location

V. Insert each submersible cord through the brass cord seals provided on the junction box and tighten completely.

W. Do not operate submersible lights or pumps more than ten seconds unless completely submerged or damage will result and warranty will be voided.

X. The installing electrical contractor will verify that all electrical equipment grounds will have the same reference potential and will give evidence of such to Delta Fountains before any equipment is initially energized.

Y. The installing contractor shall size all feed-wires leading to fountain control panel for no more than 2% voltage drop, and shall notify Delta Fountains before fabricating electrical control panel if wire is upsized such that extra large wire lugs are required. It is the responsibility of electrical contractor to provide any disconnect required by local code requirements.

Z. The fountain control panel shall be adequately protected from debris and stored properly during construction and prior to initial operation and shall be vacuumed clean and all screws for terminal connections tightened.

AA. The electrical contractor shall ensure that supply voltage is within 5% of design voltage when all equipment is in operation and shall re-tap transformer, up size wire, or supply a buck and boost transformer to get supply voltage to necessary level, if necessary.

BB. Wires for water level sensors must be run in a separate conduit to the fountain control panel.

CC. All conduit penetrations through structure walls into trade areas below the pool structure must have the necessary allowances made for settlement.

DD. Floor mounted motor control centers and transformers for fountain related equipment shall be installed on a 4” concrete housekeeping pad in equipment room.

EE. Contractor installing fountain manufacturer supplied deck boxes in concrete for fountain lighting is to ensure that all open conduit ports are plugged watertight prior to slab pour around deck boxes.

FF. All penetrations through outside walls to below grade shall be sealed per building specifications. Using “easy-link-seals” is recommended.

GG. Any and all costs associated with the above are the responsibility of installing contractor.

3.5 FIELD QUALITY CONTROL

A. Inspection and Testing, General: Labor, materials, instruments, and power for testing shall be furnished by the Contractor. All tests shall be performed to the satisfaction of the Owner, Architect, and such other parties that may have legal jurisdiction. Item or system to be tested shall not be closed up, buried, or covered until testing is completed and owner confirms approval. Prepare reports of testing activities and submit as specified.

1. Reference Division 1 Section 01400 “Quality Requirements” for related and additional provisions.

B. Piping Test:

1. Conduct piping tests before joints are covered and after thrust blocks have been hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. Flush out all pipes with clean water prior to performing leak tests.

2. Do not include equipment in tests which could be damaged by high pressure.

3. Automatic water make-up systems shall be thoroughly tested and operative at the time of final observation.

4. Pressure testing requires that a prescribed period of curing / drying time be allowed in order to allow the PVC cement to properly cure and take a permanent set. The following table sets forth the minimum drying period before the required pressure tests. Note that the table applies only to weather temperatures ranging from 50□ F. to 90□F. For drying times during temperatures that differ from this, consult the fountain manufacturer.

Piping Size	**Curing Time**
1.5” – 2.5”	8 hours
3” – 4”	18 hours
6” –8”	24 hours
10” & higher	36 hours

5. A 24-hour static pressure test of 10 ft. above highest vacuum, drainage, or gravity pipe invert elevation shall be performed on all vacuum and or gravity pipe lines using water as the medium. All vacuum and gravity drain piping shall be tested with no loss of water, pressure, or noticeable leaks. All pressure testing shall include a visual check of each

joint by the Contractor in the presence of Construction Manager, owner, authorized representative, and/or Architect.

6. The Contractor shall provide all pumps, pressure plugs, gauges, and other instruments and devices necessary to perform the hydrostatic pressure tests specified herein. Each complete discharge piping system shall be hydrostatically tested to a pressure of 150% of the system working pressure. For purposes of this test, system-working pressure shall be defined at 50 PSIG and the hydrostatic test shall be performed at 75 PSIG. Pressure test for at least 8 hours, at which time pressure shall remain constant, without additional pumping, pressure loss, or noticeable leaks. PSI is required on all pressure piping to include return inlets piping using water as the medium.

7. Pressure test all water piping prior to commencing backfill operations. Hydrostatic (water) testing shall be the only approved method. DO NOT PRESSURE TEST WITH COMPRESSED AIR as severe pipe damage and bodily injury can occur. Do not exceed the rated operational pressure of the piping and/or fittings carrying the lowest pressure rating. Locate and repair any leaks and retest prior to completion of backfill operations.

8. After the system has operated for one week, contractor and owner's representative shall inspect water make-up rates and agree that water usage is appropriate for a system of this type, are within local ordinances or codes, and that such rates are not indicative of excessive leakage from system. A water meter shall be placed on the fill line for this purpose, if necessary to document precise water usage.

C. Manufacturer's Field Services:

1. The fountain manufacturer shall be present for a minimum of 4 site coordination meetings, which includes the review of the plans and shop drawings with the mechanical, electrical, and structural disciplines. The fountain manufacturer must be available at the jobsite within a one week notice. The representative shall be a factory employee, not a local representative.

3.6 START UP AND ADJUSTMENTS

A. Manufacturer shall be present for the initial start up of the fountain system.

B. Contractor shall adjust fountain water system for volume and water flow characteristics to reflect design intent as approved by Architect.

C. Contractor shall have the following conditions satisfied prior to departure of personnel from factory.

1. All electrical connections shall be made and tested.

2. All underwater lighting shall be lamped, installed and tested

3. Thoroughly test all fixtures, services, and all circuits for proper operating conditions and freedom from grounds and short circuits before acceptance is requested. All equipment, appliances, and devices shall be operated under load conditions

4. All underwater junction boxes shall be wired and sealed with potting compound.

5. Pump and filter motors shall be power tested to insure proper impeller rotation at specified voltage.

6. Electronic water level control and/or low water cut-off control shall be installed and wired for operation.

7. All hydraulic lines and fittings shall be pressure tested for leaks, repaired as necessary, and flushed clean. Basket strainers shall be checked and cleaned as required.

8. All nozzles, jets, manifolds, headers, and spray apparatus shall be installed properly and flushed of debris as required. Final nozzle adjustment for position and throttling to achieved specified performance for all display discharge points to be performed by installing contractor.

9. Pump vaults, when supplied by manufacturer shall be thoroughly cleaned of debris, tested for electrical integrity and pressure tested for leaks.

10. Chemical feed system, when supplied, shall be filled to proper level with required dosage of chemicals. (Manufacturer does not supply chemicals unless specifically listed in proposal).

11. The fountain basin shall be thoroughly cleaned and filled to proper water level with clean, fresh water.

12. Contractor shall make available to factory personnel a plumber and electrician who have first hand knowledge of the fountain installation, at contractors own expense.

13. Contractor will perform any manual labor or provide any tools for adjustment and start-up.

D. Contractor acknowledges the above requirements and understands that, should above requirements not be completed, factory personnel may immediately cancel visit and return to factory. In such case, Contractor shall be responsible for all costs and expenses incurred by manufacturer.

3.7 DEMONSTRATION

A. Furnish complete on-site instructions and demonstration to owner in the operation, adjustment and maintenance of fountain system.

END OF SECTION 13 12 12

SECTION 32 12 16

ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 STREETS AND SIDEWALKS:

A. General Requirements
   1. The Contractor shall furnish, place, construct and incorporate into the work, parking and driveway pavements where indicated on the plans in accordance with Town of Mount Pleasant Department of Public Works and the Westchester County Department of Public Works Transportation Standard Construction Specifications.
   2. The Contractor is further directed to the Construction Details shown on the contract drawings.

1.03 DESCRIPTION OF WORK:

A. General
   1. Extent of asphalt concrete paving work is shown on the drawings including parking areas, driveways and temporary and permanent pavement replacement in areas where existing street pavements have been removed due to trenching operations.
   2. Prepared subbase is specified in Division 31 Section 312000 Earthwork.

B. Aggregate Subbase
   1. Where applicable, is specified in Division 31 Section 312000 Earthwork.

C. Material Certificates
   1. Provide copies of material certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

D. Codes and Standards
   1. Comply with New York State Department of Transportation standard specifications, latest edition and with the Town of Mount Pleasant Department of Public Works and Westchester County Departments of Public Works and Transportation governing regulations.

E. Weather Limitations
   1. Apply prime and tack coats when ambient temperature is above 50°F (10°C) and when temperature has not been below 35°F (1°C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
   2. Construct asphalt concrete surface course when atmospheric temperature is above 40°F (4°C) and only after base course and binder course have been exposed to one winter season. Base course may be placed when air temperature is above 30°F (-1°C) and rising.

F. Grade Control
   1. Establish and maintain required lines and elevations.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General
1. Use locally available materials and gradations as required by the Town of Mount Pleasant Department of Public Works and Westchester County Departments of Public Works and Transportation which exhibit a satisfactory record of previous installations.

B. Base Course Aggregate
1. Sound, angular, granular stone as specified on the plans.

C. Asphalt Concrete
1. As specified on the plans.

D. Tack Coat
1. Emulsified asphalt; AASHTO M 140 (ASTM D 997) or M 208 (D 2397); SS-1h or CSS-1h, diluted with one part water to one part emulsified asphalt.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Remove loose material from compacted subbase surface.
1. Proof roll prepared subbase with a ten ton roller to check for unstable areas and areas requiring additional compaction.
2. Notify Owner's Representative of unsatisfactory conditions. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.

B. Tack Coat
1. Apply to contact surfaces of previously constructed asphalt concrete binder course and surfaces abutting or projecting into existing asphalt concrete pavement. Distribute at rate of 0.10 gallons per square yard of surface.
2. Allow to dry until at proper condition to receive paving.
3. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

3.02 PLACING PAVEMENT MIX:

A. General
1. Place asphalt concrete mix on prepared surface, spread and strike-off. Spread mixture at minimum temperature of 225°F (107°C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section and compacted thickness.

B. Paver Placing
1. Place in strips not less than 10 feet wide, unless otherwise acceptable to Owner's Representative. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course and binder course for a section before placing surface course. Base course and binder course shall be exposed one winter season before applying surface course.

C. Joints
1. Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and

smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

3.03 ROLLING:

A. General
1. Begin rolling with a ten ton roller when mixture will bear roller weight without excessive displacement.
2. Compact mixture with hot hand tampers or vibrating place compactors in areas inaccessible to rollers.

B. Breakdown Rolling
1. Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material.

C. Second Rolling
1. Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

D. Finish Rolling
1. Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

E. Patching
1. Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

F. Protection
1. After final rolling, do not permit vehicular traffic on pavement until mixture has cooled enough not to become marked. Erect barricades to protect paving from traffic.

3.04 FIELD QUALITY CONTROL:

A. General
1. Test in-place asphalt concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by the Owner's Representative.

B. Thickness
1. In-place compacted nominal pavement thickness will not be acceptable if exceeding following allowable variation from required thickness:
Base Course: 1/4"
Binder Course: 1/4"
Surface Course: 1/4"
2. The sum total thickness of all the courses shall not vary from the total nominal thickness indicated on the plans by more than 1/2 inch.

C. Surface Smoothness
1. Test unfinished surface of each asphalt concrete course for smoothness, using 10 foot straightedge applied parallel with and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:
Base Course Surface: 1/4"
Wearing Course Surface: 1/8"

D. Crowned Surfaces
   1. Test with crowned template centered and at right angle to crown. Maximum allowable variance from template, 1/4 inch.
   2. Variations exceeding above tolerances shall be satisfactorily corrected at no additional cost to the Owner.
   3. Check surface areas at intervals as directed by the Owner's Representative.

3.05 TEMPORARY PAVEMENT:

A. Where trench excavations have been performed within an existing street, furnish and lay a temporary pavement on an approved subgrade to the lines and grades specified herein. Cut the existing pavement with suitable tools as specified in Division 31 Section 312000 Earthwork. The construction of the temporary pavement shall consist of 2 inch compacted thickness of hot-mix asphaltic concrete unless otherwise specified by the Owner's Representative.

B. Before the material is spread, paint all curb edgings, surfaces of manholes and other structures which will come into contact with the new pavement with a bituminous emulsion or priming material acceptable to the Owner's Representative. Take care to prevent staining, smearing or defacing the exposed faces of the curbs and other structures during the spreading and rolling of the material.

C. After spreading, roll the material by means of a well balanced roller weighing not less than 15 tons. In all places not accessible to the roller, compact the material thoroughly by tampers weighing not less than 25 pounds and having a bearing area not exceeding 50 square inches.

D. Maintain temporary pavement until such time that the final settlement of the trench shall have taken place in the opinion of the Owner's Representative. Correct any settlement taking place by furnishing, spreading and rolling additional material over that previously laid.

3.06 PAVEMENT REPLACEMENT:

A. In areas where temporary pavement has been placed, remove said temporary pavement to the subgrade line as specified. Bring the subgrade to the proper elevation and compact it.

B. Where specified by the Owner's Representative, excavate a shelf to provide a bearing area on all sides for the new pavement. The width of said shelf and pavement thickness shall be as shown on the plans or as directed by the Owner's Representative.

END OF SECTION 32 12 16

SECTION 32 12 17

POROUS ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.1 DESCRIPTION

A. This specification is intended to be used for porous asphalt pavement in parking lot and driveway applications.

B. The work of this Section includes subgrade preparation, installation of the underlying porous media beds, and porous asphalt mix (mix) design, production, and installation. Porous media beds refer to the material layers underlying the porous asphalt pavement. Porous asphalt pavement refers to the compacted mix of modified asphalt, aggregate, and additives.

C. The porous asphalt pavement specified herein is modified after the National Asphalt Pavement Association (NAPA) specification outlined in *Design, Construction, and Maintenance Guide for Porous Asphalt Pavements, Information Series 131* (2008) and *Design, Construction, and Maintenance of Open-Graded Friction Courses, Information Series 115* (2002) and the University of New Hampshire Stormwater Center *Design Specifications for Porous Asphalt Pavement Infiltration Beds* (2009).

D. Alternative specifications for mix, such as Open Graded Friction Courses (OGFC) from Federal Agencies or state Departments of Transportation (DOT), may be used if approved by the Engineer. The primary requirements for the specifications of the mix are performance grade (PG) asphalt binder, binder content, binder draindown, aggregate gradation, air void content, retained tensile strength (TSR).

1.2 SUBMITTALS

A. Submit a list of materials proposed for work under this Section including the name and address of the materials producers and the locations from which the materials are to be obtained.

B. Submit certificates, signed by the materials producers and the relevant subcontractors, stating that materials meet or exceed the specified requirements, for review and approval by the Engineer.

C. Submit samples of materials for review and approval by the Engineer. For mix materials, samples may be submitted only to the Quality Assurance (QA) inspector with the Engineer's approval.

D. Submittal requirements for samples and certificates are summarized in 1.3 Quality Control / Quality Assurance (QC*/QA)*

1.3 QUALITY CONTROL / QUALITY ASSURANCE (QC/QA)

A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this section.

B. Codes and Standards - All materials, methods of construction and workmanship shall conform to applicable requirements of AASHTO ASTM Standards, NYSDOT Standard Specifications, or other standards as specified.

C. QC/QA requirements for production of mix are discussed in the Materials section, and for construction of the porous media beds and paving in the Execution section.

Table 1. Submittal Requirements.

Material or Pavement Course*	Properties to be Reported on Certificate**
choker course, reservoir course	gradation, max. wash loss, min. durability index, max. abrasion loss, air voids (reservoir course)
filter course	gradation, permeability/ sat. hydraulic conductivity
filter blanket	gradation
geotextile filter fabric	manufacturer's certification, AOS/EOS, tensile strength
striping paint	certificate
binder	PGAB certification
coarse aggregate	gradation, wear, fracture faces (fractured and elongated)
fine aggregate	gradation,
silicone	manufacturer's certification
Fibers (optional)	manufacturer's certification
mineral filler (optional)	manufacturer's certification
fatty amines (optional anti-strip)	manufacturer's certification
hydrated lime (optional anti-strip)	manufacturer's certification

* Samples of each material shall be submitted to the Engineer (or QA inspector for mix). These samples must be in sufficient volume to perform the standardized tests for each material.
** At a minimum, more material properties may be required (refer to Materials Section).

1.4 PROJECT CONDITIONS

A. Site Assessment should be performed per the steps outlined in IS 131 (NAPA, 2008).

B. Construction Phasing should be performed as outlined in IS 131 (NAPA, 2008).

C. Protection of Existing Improvements

1. Protect adjacent work from the unintended dispersal/splashing of pavement materials. Remove all stains from exposed surfaces of pavement, structures, and grounds. Remove all waste and spillage. If necessary, limit access to adjacent work/structures with appropriate signage and/or barriers.

2. Proper erosion and sediment control practices shall be provided in accordance with existing regulations. Do not damage or disturb existing improvements or vegetation. Provide suitable protection where required before starting work and maintain protection throughout the course of the work. This includes the regular, appropriate inspection and maintenance of the erosion and sediment control measures.

3. Restore damaged areas, including existing pavement on or adjacent to the site that has been damaged as a result of construction work, to their original condition or repair as directed to the satisfaction of the Engineer at no additional cost.

D. Safety and Traffic Control

1. Notify and cooperate with local authorities and other organizations having jurisdiction when construction work will interfere with existing roads and traffic.

2. Provide temporary barriers, signs, warning lights, flaggers, and other protections as required to assure the safety of persons and vehicles around and within the construction area and to organize the smooth flow of traffic.

E. Weather Limitations

1. Porous asphalt, Open graded friction course, or dense-mixed asphalt shall not be placed between November 15 and March 15, or when the ambient air temperature at the pavement site in the shade away from artificial heat is below 60 °F or when the actual ground temperature is below 50 °F. Only the Engineer may adjust the air temperature requirement or extend the dates of the pavement season.

2. The Contractor shall not pave on days when rain is forecast for the day, unless a change in the weather results in favorable conditions as determined by the Engineer.

1.5 REFERENCES

A. *General Porous Asphalt Bituminous Paving and Groundwater Infiltration Beds,* specification by UNH Stormwater Center, February, 2005.

B. *Design, Construction, and Maintenance Guide for Porous Asphalt Pavements, Information Series 131*, National Asphalt Pavement Association (NAPA), 2008.

C. *Design, Construction, and Maintenance of Open-Graded Friction Courses, Information Series 115*, NAPA, 2002.

D. *Annual Book of ASTM Standards*, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition.

E. *Standards of the American Association of State Highway and Transportation Officials* (AASHTO), 1998 or latest edition.

F. *Section 02725 - General Porous Pavement and Groundwater Infiltration Beds*, specification from NAPA Porous Asphalt Seminar handout, Cahill Associates, Inc., 2004.

G. *Correlations of Permeability and Grain Size*, Russell G. Shepherd, Groundwater 27 (5), 1989.

H. *Groundwater*, R. Allan Freeze and John A. Cherry, 1979.

I. *Standards Specifications,* New York State Department of Transportation, latest edition, including all addendums.

J. University of New Hampshire Stormwater Center *Design Specifications for Porous Asphalt Pavement Infiltration Beds,* 2009.

PART 2 PRODUCTS

2.1 MATERIALS

A. Porous Media Infiltration Beds

Below the porous asphalt itself are located the porous media infiltration beds as detailed on the drawings, from top to bottom: a layer of Choker Course or crushed stone; a layer of Filter Course of

poorly graded sand (a.k.a. bankrun gravel); a layer of Filter Blanket Course, that is an intermediate setting bed (pea gravel); and a Reservoir Course of crushed stone, thickness varies as detailed on the drawings. Nonwoven geotextile filter fabric (geotextile) is used for stabilizing the sloping sides of the porous asphalt system excavation and not to be used on the bottom of the system.

1. Choker Course (6 inches thick)
   Material for the choker course and reservoir course shall meet the following:
   Maximum Wash Loss of 0.5%
   Minimum Durability Index of 35
   Maximum Abrasion Loss of 10% for 100 revolutions, and maximum of 50% for 500 revolutions.
   Material for the choker course and reservoir course shall have the AASHTO No. 57 and AASHTO No. 3 gradations, respectively, as specified in **Table 2**. If the AASHTO No. 3 gradation cannot be met, AASHTO No. 5 is acceptable with approval of the Engineer. AASHTO No. 3 is also suitable for the choker course.

2. Filter Course (10 inches thick)
   Filter course material shall have a hydraulic conductivity (also referred to as coefficient of permeability) of 10 to 60 ft/day at 95% standard proctor compaction unless otherwise approved by the Engineer. The filter course material is commonly referred to as bankrun gravel. Recycled material is not acceptable for use as a Filter Course.

3. Filter Blanket (3 inches thick)
   Filter blanket material between the filter course and the reservoir course shall be pea-gravel with a median particle diameter of 3/8-inches.

4. Reservoir Course (thickness varies, 8 inches minimum)
   Reservoir Course thickness is 8 inches minimum with depths as shown on the plans of 1-1/2 inch stone. Total pavement system and subbase thickness are greater than 0.65 * design frost depth for area.

Table 2. Gradations and compaction of choker, filter, and reservoir course materials.

US Standard Sieve Size Inches/mm	Percent Passing (%)			
	Choker Course AASHTO No. 57	**Filter Course Bank Run Gravel**	**Reservoir Course AASHTO No. 3**	**Reservoir Course Alternative* AASHTO No. 5**
6/150	-	100	-	
2½/63	-		100	-
2 /50	-		90 – 100	-
1½/37.5	100		35 – 70	100
1/25	95 - 100		0 – 15	90 – 100
¾/19	-		-	20 - 55
½/12.5	25 - 60		0 - 5	0 - 10
3/8/9.5	-		-	0 - 5
#4/4.75	0 - 10	70-100	-	
#8/2.36	0 - 5		-	
#200/0.075		0 – 4		
% Compaction ASTM D698 / AASHTO T99	95	95	95	95

* Alternate gradations (e.g. AASHTO No. 5) may be accepted upon Engineer's approval.

5. Non-woven Geotextile Filter Fabric
   Filter fabric is for the sloping sides of the porous asphalt system excavation. It shall be Mirafi 160N, or approved equal.

B. Porous Asphalt Mix

1. Mix Materials
   Mix materials consist of modified performance grade asphalt binder (PGAB), coarse and fine aggregates, and optional additives such as silicone, fibers, mineral fillers, fatty amines, and hydrated lime. Materials shall meet the requirements of the NAPA's Design, Construction, and Maintenance of Open-Graded Friction Courses, Information Series 115 (2002), except where noted otherwise below or approved in writing by the Engineer.

2. Polymer Modified PGAB and Mix Designs.
   The asphalt binder shall be a polymer and/or fiber modified Performance Graded asphalt binder (PGAB) used in the production of Superpave Hot Mix Asphalt (HMA) mixtures. The PGAB shall be two grades stiffer than that required for dense mix asphalt (DMA) parking lot installations, which is often achieved by adding a polymer and/or fiber. Mix designs will meet or exceed criteria listed in Table 5

   The PGAB polymer modifiers are to be either styrene butadiene rubber (SBR) or styrene butadiene styrene (SBS). The quantity of rubber solids in the SBR shall typically be 1.5-3% by weight of the bitumen content of the mix.

   The dosage of fiber additives shall be either 0.3 percent cellulose fibers or 0.4 percent mineral fibers by total mixture mass. The binder shall meet the requirements of AASHTO M320.

   The PGAB may be pre-blended or post-blended. The pre-blended binder can be pre-blended at the source or at a terminal. For post-blended addition, the modifier can either be in-line blended or injected into the pugmill at the plant.

   The following asphalt mix designs are acceptable:

   a. PG 64-28 with 5 pounds of fibers per ton of asphalt mix. This mix is recommended for smaller projects with lower traffic counts or loading potential. This mix is manageable at common batch plants.

   b. Pre-Blended PG 64-28 SBS with 5 pounds of fibers per ton of asphalt mix. This mix is recommended for large projects > 1acre where high durability pavements are needed. The SBS will be supplied by an approved PGAB supplier holding a Quality Control Plan approved by NYSDOT. A Bill of Lading (BOL) will be delivered with each transport of PG 64-28 SBS. A copy of the BOL will be furnished to the QA inspector at the Plant.

3. Anti-Stripping Mix Additives.
   The mix shall be tested for moisture susceptibility and asphalt stripping from the aggregate by AASHTO T283. If the retained tensile strength (TSR) < 80% upon testing, a heat stable additive shall be furnished to improve the anti-stripping properties of the asphalt binder. Test with one freeze-thaw cycle. The amount and type of additive (e.g. fatty amines or hydrated lime) to be used shall be based on the manufacturer's recommendations, the mix design test results, and shall be approved by the Engineer.

Silicone shall be added to the binder at the rate of 1 oz. per 5000 gal. Fibers may be added per manufacturer and NAPA IS 115 recommendation if the draindown requirement cannot be met (<0.3% via ASTM D6390) provided that the air void content requirement is met (>18%, or >16% as tested with CoreLok device). Additives should be added per the relevant DOT specification and NAPA IS 115.

4. Coarse Aggregate.
   Coarse aggregate shall be that part of the aggregate retained on the No. 8 sieve; it shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel of uniform quality throughout. Coarse aggregate shall be crushed stone or crushed gravel and shall have a percentage of wear as determined by AASHTO T96 of not more than 40 percent. In the mixture, at least 75 percent, by mass (weight), of the material coarser than the 4.75 mm (No. 4) sieve shall have at least two fractured faces, and 90 percent shall have one or more fractured faces (ASTM D5821). Coarse aggregate shall be free from clay balls, organic matter, deleterious substances, and a not more than 8.0% of flat or elongated pieces (>3:1) as specified in ASTM D4791.

5. Fine Aggregate.
   The fine aggregate shall be that part of the aggregate mixture passing the No. 8 sieve and shall consist of sand, screenings, or combination thereof with uniform quality throughout. Fine aggregate shall consist of durable particles, free from injurious foreign matter. Screenings shall be of the same or similar materials as specified for coarse aggregate. The plasticity index of that part of the fine aggregate passing the No. 40 sieve shall be not more than 6 when tested in accordance with AASHTO T90. Fine aggregate from the total mixture shall meet plasticity requirements.

6. Porous Asphalt Mix Design Criteria.
   The Contractor shall submit a mix design at least 10 working days prior to the beginning of production. The Contractor shall make available samples of coarse aggregate, fine aggregate, mineral filler, fibers and a sample of the PGAB that will be used in the design of the mixture. A certificate of analysis (COA) of the PGAB will be submitted with the mix design. The COA will be certified by a laboratory meeting the requirements of AASHTO R18. The Laboratory will be certified by the NYSDOT and/or qualified under ASTM D3666. Technicians will be certified by the regional certification agency in the discipline of HMA Plant Technician.

   Bulk specific gravity (SG) used in air void content calculations shall not be determined and results will not be accepted using AASHTO T166 (saturated surface dry), since it is not intended for open graded specimens (>10% AV). Bulk SG shall be calculated using AASHTO T275 (paraffin wax) or ASTM D6752 (automatic vacuum sealing, e.g. CoreLok). Air void content shall be calculated from the bulk SG and maximum theoretical SG (AASHTO T209) using ASTM D3203.

   The materials shall be combined and graded to meet the composition limits by weight as shown in Table 3.

Table 3. Porous Asphalt Mix Design Criteria

Sieve Size (inch/mm)	Percent Passing (%)
0.75/19	100
0.50/12.5	85-100
0.375/9.5	55-75
No.4/4.75	10-25
No.8/2.36	5-10
No.200/0.075 (#200)	2-4

Binder Content (AASHTO T164)	6 - 6.5%
Fiber Content by Total Mixture Mass	0.3% cellulose or 0.4% mineral
Rubber Solids (SBR) Content by Weight of the Bitumen	1.5-3% or TBD
Air Void Content (ASTM D6752/AASHTO T275)	16.0-22.0%
Draindown (ASTM D6390)*	< 0.3 %
Retained Tensile Strength (AASHTO 283)**	> 80 %
Cantabro abrasion test on unaged samples (ASTM D7064-04)	< 20%
Cantabro abrasion test on 7 day aged samples	< 30%

C. Porous Asphalt Mix Production

1. Mixing Plants
   Mixing plants shall meet the requirements of hot mix asphalt plants as specified in the NYSDOT.

2. Preparation of Asphalt Binder
   The asphalt material shall be heated to the temperature specified in the NYSDOT specification in a manner that will avoid local overheating. A continuous supply of asphalt material shall be furnished to the mixer at a uniform temperature.

3. Preparation of Aggregates
   The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damaging the aggregate and depositing soot or unburned fuel on the aggregate.

4. Mineral filler
   Mineral filler if required to meet the grading requirements, shall be added in a manner approved by the Engineer after the aggregates have passed through the dryer.

5. Mixing
   The above preparation of aggregates does not apply for drum-mix plants. The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregate required to meet the job-mix formula and thoroughly mixed prior to adding the asphalt material.

   The dried aggregates shall be combined with the asphalt material in such a manner as to produce a mixture that when discharged from the pugmill is at a target temperature in the range that corresponds to an asphalt binder viscosity of 700 to 900 centistokes and within a tolerance of ± 20 °F.

   The asphalt material shall be measured or gauged and introduced into the mixer in the quantity determined by the Engineer for the particular material being used and at the temperature specified in the relevant specification.

   After the required quantity of aggregate and asphalt material has been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt material throughout the aggregate is secured. The mixing time will be regulated by the Engineer.

All plants shall have a positive means of eliminating oversized and foreign material from being incorporated into the mixer.

6. QC/QA During Production

The Contractor shall provide at Contractors' expense and the Engineer's approval a third-party QA Inspector to oversee and document mix production. All mix testing results during production should be submitted to the QA Inspector.

The QC plan may be altered at the discretion of the Engineer and based on feasible testing as suggested by the asphalt producer. Certain QC testing requirements during production may not be feasible for small projects in which limited asphalt is generated. Some testing methods cannot be completed during the time needed during small batch production. The feasibility should be assessed with the Engineer and producer.

The mixing plant shall employ a Quality Control Technician (QCT). The QCT will perform QC/QA testing and will be certified in the discipline of HMA Plant Technician by the relevant certifying agency. The Contractor shall sample, test and evaluate the mix in accordance with the methods and minimum frequencies in Table 4 and the Post-Blended SBR Binder Quality Control Plan (if applicable).

Table 4. QC/QA Testing Requirements during Production

Test	Min. Frequency	Test Method
Temperature in Truck at Plant	6 times per day	
Gradation	greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T30
Binder Content	greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T164
Air Void Content	greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	ASTM D6752
Binder Draindown	greater of either (a) 1 per 500 tons, (b) 1 per day, or (c) 1 per job	ASTM D6390

If an analyzed sample is outside the testing tolerances immediate corrective action will be taken. After the corrective action has been taken the resulting mix will be sampled and tested. If the re-sampled mix test values are outside the tolerances the Engineer will be immediately informed. The Engineer may determine that it is in the best interest of project that production is ceased. The Contractor will be responsible for all mix produced for the project.

Testing Tolerances During Production. Testing of the air void content, binder draindown, and TSR shall be within the limits set in Table 4. The paving mixture produced should not vary from the design criteria for aggregate gradation and binder content by more than the tolerances in Table 5.

Table 5. QC/QA Testing Tolerances during production

Sieve Size (inch/mm)	Percent Passing
0.75/19	-
0.50/12.5	±6.0
0.375/9.5	±6.0
No.4/4.75	±5.0

No.8/2.36	±4.0
No.200/0.075 (#200)	±2.0
%PGAB	+0.4, -0.2

Should the paving mixture produced vary from the designated grading and asphalt content by more than the above tolerances, the appropriate production modifications are to be made until the porous asphalt mix is within these tolerances.

Samples of the mixture, when tested in accordance with AASHTO T164 and T30, shall not vary from the grading proportions of the aggregate and binder content designated by the Engineer by more than the respective tolerances specified above and shall be within the limits specified for the design gradation.

7. Plant Shutdown and Rejection of Mix
Should the porous asphalt mix not meet the tolerances specified in this section upon repeat testing, the Engineer may reject further loads of mix. Mix that is loaded into trucks during the time that the plant is changing operations to comply with a failed test shall not be accepted, and should be recycled at the plant.

8. Striping Paint
Striping paint shall be latex, water-base emulsion, ready-mixed, and complying with pavement marking specifications.

PART 3 EXECUTION

3.1 INSTALLATION

A. **Porous Media Beds**
Protection of native materials from over compaction is required. Assure proper compaction as detailed below.

1. Grade Control

   a. Establish and maintain required lines and elevations. The Engineer shall be notified for review and approval of final stake lines for the work before construction work is to begin. Finished surfaces shall be true to grade and even, free of roller marks and free of puddle forming low spots. All areas must drain freely. Excavation elevations should be within +/- 0.1 ft.

   b. If, in the opinion of the Engineer, based upon reports of the testing service and inspection, the quality of the work is below the standards which have been specified, additional work and testing will be required until satisfactory results are obtained.

   c. The Engineer shall be notified at least 24 hours prior to all porous media bed and porous pavement work.

2. Subgrade Preparation

   a. Native subgrade refers to materials beyond the limit of the excavation. The existing native subgrade material under all bed areas shall NOT be compacted or subject to excessive construction equipment traffic prior to geotextile and stone bed placement.

b. Where erosion of the native material subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake or equivalent and light tractor.

c. Bring subgrade to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before the placing of the stone subbase.

d. All bed bottoms are as level as feasible to promote uniform infiltration. For pavements subbases constructed on grade, soil or fabric barriers should be constructed along equal elevation for every 6 to 12 inches of grade change to act as internal check dams.

3. Porous Media Bed Installation

a. Subbase refers to materials below pavement surface and above native subgrade. Upon completion of subgrade work, the Engineer shall be notified and shall inspect at his/her discretion before proceeding with the porous media bed installation.

b. Sideslope geotextile and porous media bed aggregate shall be placed immediately after approval of subgrade preparation. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of geotextile at no extra cost to the Owner.

c. Place sideslope geotextile in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of sixteen inches (16"). Secure geotextile at least four feet outside of the bed excavation and take any steps necessary to prevent any runoff or sediment from entering the storage bed.

d. Install filter course aggregate in 8-inch maximum lifts to a MAXIMUM of 95% standard proctor compaction (ASTM D698 / AASHTO T99). Install aggregate to grades indicated on the drawings.

e. Install choker, gravel, and stone base course aggregate to a MAXIMUM of 95% compaction standard proctor (ASTM D698 / AASHTO T99). Choker should be placed evenly over surface of filter course bed, sufficient to allow placement of pavement, and notify Engineer for approval. Choker base course thickness shall be sufficient to allow for even placement of the porous asphalt but no less than 6-inches in depth.

f. The density of subbase courses shall be determined by AASHTO T 191 (Sand-Cone Method), AASHTO T 204 (Drive Cylinder Method), or AASHTO T 238 (Nuclear Methods), or other approved methods at the discretion of the supervising engineer.

g. The infiltration rate of the compacted subbase shall be determined by ASTM D3385 or approved alternate at the discretion of the supervising engineer. The infiltration rate shall be no less 5-30 ft/day or 50% of the hydraulic conductivity (D2434) at 95% standard proctor compaction (refer to section 2.1.A.5).

h. Compaction of subbase course material shall be done with a method and adequate water to meet the requirements. Rolling and shaping shall continue until the required density is attained. Water shall be uniformly applied over the subbase course materials during compaction in the amount necessary for proper consolidation.

i. Rolling and shaping patterns shall begin on the lower side and progress to the higher side of the subbase course while lapping the roller passes parallel to the centerline. Rolling and shaping shall continue until each layer conforms to the required grade and cross-section and the surface is smooth and uniform.

j. Following placement of subbase aggregate, the sideslope geotextile shall be folded back along all bed edges to protect from sediment washout along bed edges. At least a four-foot edge strip shall be used to protect beds from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and vegetated. In addition, take any other necessary steps to prevent sediment from washing into beds during site development. When the site is fully stabilized, temporary sediment control devices shall be removed.

B. **Porous Asphalt Pavement Installation**

1. Mixing Plant
The mixing plant, hauling and placing equipment, and construction methods shall be in conformance with NAPA IS 131 and applicable sections of the NYSDOT's specification for asphalt mixes.

2. Hauling Equipment.
The open graded mix shall be transported in clean vehicles with tight, smooth dump beds that have been sprayed with a non-petroleum release agent or soap solution to prevent the mixture from adhering to the dump bodies. Mineral filler, fine aggregate, slag dust, etc. shall not be used to dust truck beds. The open graded mix shall be covered during transportation with a suitable material of such size sufficient to protect the mix from the weather and also minimize mix cooling and the prevention of lumps. When necessary, to ensure the delivery of material at the specified temperature, truck bodies shall be insulated, and covers shall be securely fastened. Long hauls, particularly those in excess of 25 miles may result in separation of the mix and its rejection.

3. Placing Equipment.
The paver shall be a self-propelled unit with an activated screed or strike-off assembly, capable of being heated if necessary and capable of spreading and finishing the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross-sectional shape. The finished surface shall be of uniform texture and evenness and shall not show any indication of tearing, shoving, or pulling of the mixture. Pavers shall be equipped with the necessary attachments, designed to operate electronically, for controlling the grade of the finished surface. Pavers shall be equipped with a sloped plate to produce a tapered edge at longitudinal joints.

The sloped plate shall be attached to the paver screed extension. The sloped plate shall produce a tapered edge having a face slope of 1:3 (vertical:horizontal). The plate shall be so constructed as to accommodate compacted mat thickness from 1 1/4 to 4 inches. The bottom of the sloped plate shall be mounted 3/8 to 1/2 inch above the existing pavement. The plate shall be interchangeable on either side of the screed.

Pavers shall also be equipped with a joint heater capable of heating the longitudinal edge of the previously placed mat to a surface temperature of 200 °F, or higher if necessary, to achieve bonding of the newly placed mat with the previously placed mat. This shall be done without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately behind the joint heater. The joint heater shall be equipped with automated controls that shut off the burners when the pavement machine stops and reignite them with the forward movement of the paver. The joint heater shall heat the entire area of the previously

placed wedge to the required temperature. Heating shall immediately precede placement of the asphalt material.

4. Rollers.
   Rollers shall be capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the asphalt mixture. The weight of the rollers shall be sufficient to compact the mixture to the required density without crushing of the aggregate.

   Rollers shall be Porous equipped with tanks and sprinkling bars for wetting the rolls. Rollers shall be two-axle tandem rollers with a gross weight of not less than 8 tons and not more than 12 tons and shall be capable of providing a minimum compaction effort of 250 pounds per inch of width of the drive roll. All rolls shall be at least 42 inches in diameter. A rubber tired roller will not be required on the open graded asphalt friction course surface.

5. Conditioning of Existing Surface.
   Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Type RS-1 emulsified asphalt immediately before the asphalt
   mixture is placed against them.

6. Temperature Requirements.
   The temperature of the asphalt mixture, at the time of discharge from the haul vehicle and at the paver, shall be between 275 to 325°F, within 10 °F of the compaction temperature for the approved mix design.

7. Spreading and Finishing.
   The Porous Asphalt shall be placed either in two lifts. Care must be taken to insure that the porous asphalt layers join completely. Keep the time between layer placements minimal; keep the first layer clear from dust and moisture, and minimize traffic on the first layer.

   The Contractor shall protect all exposed surfaces that are not to be treated from damage during all phases of the pavement operation.

   The asphalt mixture shall be spread and finished with the specified equipment. The mixture shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, has the required thickness and conforms to the grade and elevation specified. Pavers shall be used to distribute the mixture over the entire width or over such partial width as practical. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture shall be spread and raked by hand tools.

   No traffic will be permitted on material placed until the material has been thoroughly compacted and has been permitted to cool to below 100 °F. The use of water to cool the pavement is not permitted. The Engineer reserves the right to require that all work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, is completed prior to placing the wearing course when this work could cause damage to the pavement. On projects where traffic is to be maintained, the Contractor shall schedule daily pavement operations so that at the end of each working day all travel lanes of the roadway on which work is being performed are paved to the same limits. Suitable aprons to transition approaches, where required, shall be placed at side road intersections and driveways as directed by the Engineer.

8. Compaction.
   Immediately after the asphalt mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The compaction objective is

16% - 19% in place void content (Corelock). Breakdown rolling shall occur when the mix temperature is between 275 to 325°F. Intermediate rolling shall occur when the mix temperature is between 200 to 275°F.

Finish rolling shall occur when the mix temperature is between 150 to 200°F.
The cessation temperature occurs at approximately 175°F, at which point the mix becomes resistant to compaction. If compaction has not been done at temperatures greater than the cessation temperature, the pavement will not achieve adequate durability. The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving.

Rollers or oscillating vibratory rollers, ranging from 8-12 tons, shall be used for compaction. The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

To prevent adhesion of the mixture to the rolls, rolls shall be kept moist with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons or with mechanical tampers. On depressed areas, either a trench roller or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Other combinations of rollers and/or methods of compacting may be used if approved in writing by the Engineer, provided the compaction requirements are met.

Unless otherwise specified, the longitudinal joints shall be rolled first. Next, the Contractor shall begin rolling at the low side of the pavement and shall proceed towards the center or high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller should be kept in as continuous operation as practical. Rolling shall continue until all roller marks and ridges have been eliminated.

Rollers will not be stopped or parked on the freshly placed mat.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by the Engineer using cores provided by the Contractor.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture. The mixture shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of binder shall be removed and replaced. These replacements shall be at the Contractor’s expense.

If the Engineer determines that unsatisfactory compaction or surface distortion is being obtained or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment.

The Contractor assumes full responsibility for the cost of repairing all damages that may occur to roadway or parking lot components and adjacent property if vibratory compaction equipment is used. After final rolling, no vehicular traffic of any kind shall be permitted on the surface until cooling and hardening has taken place, and in no case within the first 48 hours. For small batch jobs, curing can be considered to have occurred after the surface temperature is less than 100 ºF.

Curing time is preferably one week, or until the entire surface temperature cools below 100 ºF. Provide barriers as necessary at no extra cost to the Owner to prevent vehicular use; remove at the discretion of the Engineer.

9. Joints.
Joints between old and new pavements or between successive day's work shall be made to ensure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a joint constructed.

Butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at locations approved by the Engineer. The Engineer will determine locations by using a straightedge at least 16 feet long. The butt joint shall be thoroughly coated with Type RS-1 emulsified asphalt just prior to depositing the pavement mixture when pavement resumes.

Tapered joints shall be formed by tapering the last 18 to 24 inches of the course being laid to match the lower surface. Care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with Type RS-1 emulsified asphalt just prior to resuming pavement. As the paver places new mixture on the taper area, an evenly graduated deposit of mixture shall complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake, coarse material discarded, and properly rolled.

Longitudinal joints that have become cold shall be coated with Type RS-1 emulsified asphalt before the adjacent mat is placed. If directed by the Engineer, joints shall be cut back to a clean vertical edge prior to applying the emulsion.

10. Surface Tolerances.
The surface will be tested by the Engineer using a straightedge at least 16 feet in length at selected locations parallel with the centerline. Any variations exceeding 1/8 inch between any two contact points shall be satisfactorily eliminated. A straightedge at least 10 feet in length may be used on a vertical curve. The straightedges shall be provided by the Contractor.

Work shall be done expertly throughout, without staining or injury to other work. Transition to adjacent impervious asphalt pavement shall be merged neatly with flush, clean line. Finished pavement shall be even, without pockets, and graded to elevations shown on drawing.

Porous pavement beds shall not be used for equipment or materials storage during construction, and under no circumstances shall vehicles be allowed to deposit soil on paved porous surfaces.

11. Repair of Damaged Pavement.
Any existing pavement on or adjacent to the site that has been damaged as a result of construction work shall be repaired to the satisfaction of the Engineer without additional cost to the Owner.

12. Striping Paint
Vacuum and clean surface to eliminate loose material and dust.

Paint parking striping and traffic lane striping in accordance with layouts of plan. Apply paint with mechanical equipment to produce uniform straight edges. Apply in two coats at manufacturer's recommended rates. Provide clear, sharp lines using white traffic paint

C. **QC/QA for Paving Operations**

1. The full permeability of the pavement surface shall be tested by application of clean water at the rate of at least 5 gpm over the surface, using a hose or other distribution devise. Water used for the test shall be clean, free of suspended solids and deleterious liquids and will be provided at no extra cost to the Owner. Sufficient water volume shall be provided to thoroughly test all paved areas. All applied water shall infiltrate directly without large puddle formation or surface runoff, and shall be observed by the Engineer.

2. Testing and Inspection: Employ at Contractor's expense an inspection firm acceptable to the Engineer to perform soil inspection services, staking and layout control, and testing and inspection of site grading and pavement work. Inspection and list of tests shall be reviewed and approved in writing by the Engineer prior to starting construction. All test reports must be signed by a licensed Engineer.

3. Test in-place base and surface course for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable work as directed by the Engineer.

4. Surface Smoothness: Test finished surface for smoothness using a 10 foot straightedge applied parallel with and at right angles to the centerline of the paved area. Surface will not be accepted if gaps or ridges exceed 3/16 of an inch.

5. QC/QA requirements during paving are summarized in TABLE 6.

Table 6. QC/QA Requirements During Paving

Activity	Schedule/ Frequency	Tolerance
Inspect truck beds for pooling (draindown)	every truck	NA
Take surface temp behind joint heater	each pull	10°F of compaction temp
Consult with Engineer to determine locations of butt joints	as needed	NA
Test surface smoothness & positive drainage with a 10 ft straightedge	after compaction	3/16"
Consult with Engineer to mark core locations for QA testing	after compaction	NA
Hose test with at least 5 gpm water	after compaction	immediate infiltration, no puddling

END OF SECTION 32 12 15

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SECTION 32 13 13

CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 DESCRIPTION OF WORK:

A. General
   1. Extent of cement concrete paving is shown on drawings for all walks.
   2. Prepared subbase is specified in Division 31 Section 312000 Earthwork.

1.03 QUALITY ASSURANCE:

A. Codes and Standards
   1. Comply with local governing regulations if more stringent than herein specified.

B. Submittals
   1. Furnish samples, manufacturer's product data, test reports and materials' certifications as required in referenced sections for concrete and joint fillers and sealers.

1.04 JOB CONDITIONS:

A. No concrete shall be placed in the work when the temperature is below 32^{o}F or when the temperature is likely, in the opinion of the Owner's Representative, to drop to 32^{o}F within the next 24 hours, except with the prior approval of the Owner's Representative and under special protective measures approved by the Owner's Representative.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Forms
   1. Steel, wood or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms free of distortion and defects.
   2. Use flexible spring steel forms or laminated boards to form radius bends as required.
   3. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.

B. Welded Wire Mesh
   1. Welded plain cold-drawn steel wire fabric, ASTM A 185.

C. Reinforcing Bars
   1. Deformed steel bars, ASTM A 615, Grade 40.

D. Concrete Materials
1. Comply with requirements applicable for concrete materials, admixtures, bonding materials, curing materials and others as required.

E. Expansion Joint Materials
1. Comply with requirements for preformed expansion joint fillers and sealers.

PART 3 - EXECUTION

3.01 CONCRETE MIX, DESIGN AND TESTING:

A. General
1. Comply with requirements applicable for concrete mix design, sampling and testing, and quality control, and as herein specified.
1. Design mix to normal-weight concrete consisting of Portland cement, aggregate, water-reducing or high-range water-reducing admixture (super-plasticizer), air-entraining admixture and water to produce the following properties:
   a. Compressive Strength: 4,000 psi, minimum at 28 days, unless otherwise indicated.
   b. Slump Range: 4 inches for concrete containing HPWR admixture (super-plasticizer); 4 inches for other concrete.
   c. Air Content: 4.5 to 7.5 percent.

3.02 SURFACE PREPARATION:

A. General
1. Remove loose material from compacted subbase surface immediately before placing concrete.
2. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.03 FORM CONSTRUCTION:

A. General
1. Set forms to required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
2. Check completed formwork for grade and alignment to following tolerances:
   a. Top of forms not more than 1/8 inch in 10 feet.
   b. Vertical face on longitudinal axis, not more than 1/4 inch in 10 feet.
3. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

3.04 REINFORCEMENT:

A. General
1. Locate, place and support reinforcement as shown on details, unless otherwise indicated.

3.05 CONCRETE PLACEMENT:

A. General
1. Comply with requirements for mixing and placing concrete and as herein specified.
2. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is

placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator.
4. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
5. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place a construction joint.

3.06 JOINTS:

A. General
1. Construct expansion, weakened-plane (contraction) and construction joints true-to-line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.
2. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints
1. Place construction joints at end of placements and at locations where placement operations are stopped for a period of more than 1/2 hour, except where such placements terminate at expansion joints.

C. Expansion Joints
1. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.
2. Locate expansion joints at 20 feet o.c. maximum, unless otherwise indicated.
3. Extend joint fillers full-width and depth of joint, recessed 1/2 inch below finished concrete surface.
4. Furnish joint fillers in one-place lengths for full width being place.
5. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

D. Fillers and Sealants
1. All joints shall receive joint sealants. Comply with requirements for preparation of joints, materials, installation and performance.

3.07 CONCRETE FINISHING:

A. General
1. Protect and cure finished concrete paving as specified on the plans and details. Use membrane-forming curing and sealing compound or approved moist-curing methods.

B. Anti-Spalling Treatment
1. A second coat of curing and sealing compound may be used or an anti-spalling compound applied over concrete cured by continuous moist curing methods. Apply compounds to concrete surfaces no sooner than 28 days after placement, to clean, dry concrete free of oil, dirt and other foreign material. Apply curing and sealing compound at a maximum coverage rate of 300 square feet per gallon. Apply anti-spalling compound in two sprayed applications. First application at rate of 40 square yards per gallon; second application, 60 square yards per gallon. Allow complete drying between applications.

3.08 REPAIRS AND PROTECTIONS:

A. General

1. Repair or replace broken or defective concrete, as directed by Owner's Representative.
2. Drill test cores where directed by Owner's Representative when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.
3. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
4. Sweep concrete pavement and wash free of stains, discolorations, dirt and foreign material just prior to final inspection.

END OF SECTION 32 13 13

SECTION 32 13 73

PAVEMENT JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.

1.03 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Pavement-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

D. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

1.05 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer [or are below 40˚F (5˚C)].
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.02 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.03 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.

2.04 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance. All expansion and isolation joints including work adjacent to structures and other materials shall receive a joint sealant.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

D. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.04 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.06 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.
   1. Joint Location:
      a. Expansion and isolation joints in cast-in-place concrete pavement.
      b. Contraction joints in cast-in-place concrete slabs.
      c. Other joints as indicated.

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
   1. Joint Location:
      a. Joints between concrete and asphalt pavement.
      b. Joints between concrete curbs and asphalt pavement.
      c. Other joints as indicated.

END OF SECTION 32 13 73

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SECTION 32 14 13

PRECAST CONCRETE UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Applications of pavements using paving materials and patterns; a combination of different pre-cast concrete pavers (modular units) using setting and base material requirements as shown and specified.

a. Precast concrete pavers set on ¾" thick bituminous setting bed over concrete base slab.

B. Related Sections include the following:

1. Section 32 05 23 – "Concrete for Exterior Improvements" placing concrete base slab under unit pavers.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. Installer Qualifications for Unit Paver Installation: An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project; can exhibit proof of a minimum of five (5) years prior successful experience with paving installations; and whose work has resulted in construction of equivalent type with a record of successful in-service performance.

1. Paving Installation Foreman: Installation firm for paving and surfacing of this Project shall have on staff a supervising Foreman assigned full time to this Project, from time of mock-up installations, who shall have at least 20 years total unit paving installation experience and with at least 10 years experience in paving installations of equivalent or more extensive type and scope to this Project. Submit detailed resume of past experience with dates, duration and scope identification, Project Name and location, and work function of previous projects worked on.

2. Use numbers of skilled workmen equal to work requirement or occasion. The skilled workmen shall be thoroughly trained and experienced in the necessary crafts and shall be completely familiar with specific requirements and methods needed for performance of the work of this Section.

3. Source Limitations for Unit Paving Systems Materials: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

4. The Contractor by commencing the work of this Section, assumes overall responsibility, as part of his warranty of the work, to assure that all assemblies, components and parts shown or required within the work of this Section, comply with the Contract Documents. The Contractor shall further warrant:

    a. That all components, specified or required to satisfactorily complete the installation, are compatible with each other and with the conditions of installation and expected use.
    b. The overall effective integration and correctness of individual parts and the whole of the system.
    c. Compatibility with adjoining substrates, materials and work of other trades.
    d. There shall be no premature material failure due to improper manufacture or fabrication and installation of the paving units. All materials are to fully perform to their normal life expectancy.
    e. Any piece or pieces which may be rejected after having been set shall be carefully cut out and replaced with new suitable paver unit without delay, and without cost to the Owner. Any piece or pieces damaged in the removal and resetting of defective pieces shall also be removed, and suitable, approved pieces provided and set.

5. Field Samples/Mockups for Unit Pavers: Before installing unit pavers, construct field samples/mockups for each form and pattern of unit pavers required to verify selections made under Sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Construct to comply with the following requirements, using materials indicated for the completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:

    a. Construct field samples/mockups in the location as directed by Construction Manager. Install paving surface field sample/mock-up, 6 feet by 6 feet, complete with jointing materials and setting bed indicated over concrete base slab and with typical expansion joint.
        1) For Pre-Cast Concrete Pavers: Include field units, border units, corners and transitions for each paver type.

    b. Notify Owner’s Representative seven days in advance of dates and times when field samples/mockups will be constructed.
    c. Demonstrate the proposed range of aesthetic effects and workmanship.
    d. Obtain Landscape Architect's approval of field samples/mockups before starting unit paver installations of Project.
    e. Maintain mockups during construction in an undisturbed condition as a standard for judging the subsequent completed work.
    f. Demolish and remove field samples/mock ups at a time approved by the Owner’s Representative and when no longer required to serve as a standard of work.
    g. Approved mockups at appropriate location may become part of the completed Work if undisturbed at time of Substantial Completion.
    h. Contractor shall schedule a meeting with the paver manufacturer and installer and the Landscape Architect at a time sufficiently in advance of paving installations to permit coordination. In addition, include in appropriate sequence, representatives of other related work.
    i. At the meeting, review paving system quality control requirements including details of construction, outstanding submittals, contract drawings and specifications, and on site conditions affecting or which may affect installations.

1.4 SUBMITTALS

A. Qualification Data: Submit evidence of installer qualifications as specified in Article "Quality Assurance" herein to demonstrate installer's capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Product Data: For each component, each type and condition to include proposed sources of supply and material technical data, including the following:

1. For Pre-Cast Concrete Unit Paving Material:

a. Submit test reports and descriptive data for pre-cast concrete pavers as manufactured, each type and finish, to confirm material composition and compliance with specification criteria.

2. For Setting/Installation/Subbase Materials:

a. Submit material certification and analysis report for each type bituminous setting bed material component and test reports for each subbase component for permeable pavements including geotextiles.

C. Shop Drawings:

1. For Field Sample/Mock-ups: Submit shop drawings for each Field Sample/Mock-up to be constructed as specified in Article "Quality Assurance" herein. Include all details and elements of paving system to be constructed, including base slab construction, and show location for each that has prior acceptance of Owner's Representative. Coordinate details and installations of related work such as edgings and joint sealants.

a. Submit general setting layout based on surveyed control points and dimensions to confirm paving patterns and joint spacing, locations, and alignments with adjacent conditions.

b. Identify and show location, type, and extent of anticipated field cutting and confirm that units to be cut are not less than specified minimum sizes for cutting.

D. Samples for Initial Selection:

1. Pre-Cast Concrete, Unit Paving Materials: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of unit paver indicated.

2. Joint Treatment Materials: Submit for each condition of use to show selected color(s) and types. Dry materials shall be submitted in one (1) pound packages.

E. Samples for Verification: The Landscape Architect's review will be for color, texture, and finish only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1. Pre-Cast Concrete Unit Paving Materials:

a. Full-size units of each type of unit paver indicated (field, border); in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

b. Provide Paver Unit Samples mounted on rigid board with joints filled and cured, showing the full range of colors of both pavers and joint treatment to be expected in the completed Work.

2. Accessory Items: Submit for each in size representative of item.

1.5 DELIVERY, STORAGE & HANDLING

A. Protect unit pavers, aggregate and other system components during storage and construction.

1. Protect against soiling or contamination from earth and other materials.

2. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

4. Store liquids in tightly closed containers protected from freezing.

5. Store asphalt cement and other bituminous materials in tightly closed containers.

B. Handle each paving unit material to prevent chipping, breakage, soiling, or other damage.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:

1. Hot-Weather Requirements: Protect unit paver work when temperature and humidity conditions produce excessive evaporation of water from setting beds. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply setting bed to substrates with temperatures of 100 deg F or higher.

a. When ambient temperature exceeds 90 deg F with a wind velocity greater than 8 mph (13 km/h), set pavers within 1 minute of spreading setting-bed.

2. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen sub-grade or setting beds. Remove and replace unit paver work damaged by frost or freezing. Comply with cold weather limitations and requirements specified herein.

3. Cold-Weather Limitations: Comply with the following requirements:

a. Protect unit paving material and components against freezing when atmospheric temperature is 40 deg F and falling. When conditions require, heat materials to provide temperatures between 40 and 120 deg F.

b. Provide the following protection for completed portions of work for 24 hours after installation when the mean daily air temperature is as indicated: below 40 deg F, cover with weather-resistant membrane; below 25 deg F, cover with insulating blankets; below 20 deg F, provide enclosure and temporary heat to maintain temperature above 32 deg F.

c. Maintain minimum ambient temperatures of 50 deg F during installation of stone paving and for 7 days after completion, unless higher temperatures are required by fabricator's or supplier's instructions.

4. Cold-Weather Limitations for Bituminous Setting Bed: Comply with the following requirements:

   a. Apply asphalt adhesive when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when base is wet or contains excess moisture.
   b. Install bituminous setting bed only when atmospheric temperature is above 40 deg F and when base is dry.

5. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until stone masonry has dried out, but not less than 7 days after completing cleaning.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE PAVERS

A. Pre-cast concrete pavers shall be as manufactured by Hanover Architectural Products, 5000 Hanover Road, Hanover, PA 17331, (800) 426-4242 or approved equal. Pre-cast concrete pavers shall conform to the following:

1. Average Minimum Compressive Strength: 8500 psi

2. Max. Absorption Rate: 5%

3. Modulus of Rupture: 1,100 psi at 2" thick

4. Minimum Weight: 25 lbs./sq. ft. at 2" thick

5. Single homogeneous mix.

6. Thicknesses: As shown on drawings

7. Color and Finish: As shown on drawings

B. Precast Concrete Paver Types: The following establishes an acceptable color range, and finish:

1. Prest Pavers:

   a. Size: 12"x12"
   b. Color: Limestone Gray
   c. Finish: Tudor

2.2 INSTALLATION MATERIALS FOR BITUMINOUS SETTING BED APPLICATION

A. Bituminous Setting Bed Materials

1. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.

2. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3

3. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or AC-20

4. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

B. Joint Treatment Materials (For Pre-Cast Concrete Pavers): Joint Filler shall be sand pigmented to match color of paver units.

1. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve. Provide sand of color needed to produce required joint color.

2. Color additive shall be as manufactured by Davis Colors, Lehigh Cement, Scofield, or approved equal.

2.3 BITUMINOUS SETTING BED MIX

A. Mix bituminous setting bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate, unless otherwise indicated. Heat mixture to 300 deg F.

B. Bituminous setting material mixes shall be delivered to and placed at job site together with paver unit installations while still hot.

2.4 EDGE RETRAINT

A. Edge restraint shall be Edge 300 as manufactured by Hanover Architectural Products, 5000 Hanover Road, Hanover, PA 17331, (800) 426-4242, or approved equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive paving and conditions under which paving will be installed, with Installer present. Check for compliance with requirements for installation tolerances and other conditions affecting performance of paving for each condition of installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Concrete base slab shall be provided in accordance with Section 32 05 23 - Cement and Concrete for Exterior Improvements. Slab shall have a broom finish and shall be acceptable to paving systems Installer. Coordinate with work of concrete placement and make corrections as necessary.

B. Layout of Work: Accurately lay out paving work to patterns and to fit conditions as indicated, encountered on site, and specified for installation. Comply with set out control points as indicated and coordinate with other work of Project. Provide additional control points and stakeouts as required to effect correct alignments and grade elevations. Advise Owner's Representative of any discrepancies or on-site conditions detrimental to critical layouts and obtain approved correction.

C. Prior to prime application and setting bed placements, verify base slab placement to correct line and grade and with correct finish and clean base surface.

1. Vacuum clean concrete substrates to remove dirt, dust, debris, and loose particles.

2. Remove substances from concrete substrates that could impair mortar bond including curing and sealing compounds, form oil, and laitance.

D. Clean unit paver surfaces that have become dirty or stained by removing soil, stains and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clean water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION, GENERAL

A. Do not use paving materials with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

B. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. Scribe and field cut pavers as necessary to fit at obstructions. Produce tight and neat joints.

C. Joint pattern: Set unit pavers to comply with Contract Documents.

D. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

E. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions.

3.4 BITUMINOUS SETTING BED APPLICATIONS FOR PRECAST CONCRETE PAVERS

A. Apply primer to concrete slab immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to sub-grades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each

panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of 3/4 inch while still hot. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated.

2. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling. If troweled on, use trowel with serrations not exceeding 1/16 inch. Proceed with setting of paving units only after adhesive is dry to the touch.

3. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Place unit pavers with hand-tight joints

    a. Hand tight joints shall read from 0 inches to 1/16 inches maximum
    b. Fit pavers to conditions of surface penetrating elements. Conform to specified cutting and joint width requirements

4. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers.

5. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

D. Joint Treatment: Fill joints with dry mixture of pigmented sand by sweeping over paved surface until joints are filled. Vibrate with a plate type compactor.

1. Repeat operation until joints are completely full and flush. Remove excess sand mixture from surfaces. Fog lightly with water. Cement stains that remain should be cleaned with a 10% solution of muriatic acid or mortar cleaner, or swept with moist sand until stain is removed as approved by Landscape Architect.

3.5 REPAIR, CLEANING & PROTECTION

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess dirt/infill from exposed paver surfaces; wash and scrub clean.

C. Prohibit traffic from installed unit paver installations for a minimum of 72 hours

END OF SECTION 32 14 13

SECTION 32 16 00

CONCRETE CURB

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 DESCRIPTION OF WORK:

A. General
   1. Perform all the work required to provide and install concrete curbing shown on the Drawings and/or mentioned in the Specifications.

1.03 QUALITY ASSURANCE:

A. Codes and Standards
   1. Comply with state and/or local governing regulations if more stringent than herein specified.

B. Submittals
   1. Furnish samples, manufacturer's product data, test reports and materials' certifications as required in referenced sections for concrete and joint fillers and sealers.

1.04 JOB CONDITIONS:

A. General
   1. No concrete shall be placed in the work when the temperature is below 32^{o}F or when the temperature is likely, in the opinion of the Owner's Representative, to drop to 32^{o}F within the next 24 hours, except with the prior approval of the Owner's Representative and under special protective measures approved by the Owner's Representative.
   2. No installation of curbing shall be performed prior to installation of all underground utilities in the area.
   3. No excavation under new curbing shall be performed unless approved by the Owner's Representative. Any curb damaged shall be replaced by the Contractor at no cost to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Forms
   1. Steel, wood or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
   2. Use flexible spring steel forms or laminated boards to form radius bends as required.
   3. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.

B. Concrete Materials
   1. Comply with requirements applicable for concrete materials, admixtures, bonding materials, curing materials and others as required.

C. Expansion Joint Materials
   1. Comply with requirements for preformed expansion joint fillers and sealers.

PART 3 - EXECUTION

3.01 CONCRETE MIX, DESIGN AND TESTING:

A. General
   1. Comply with requirements applicable for Class "A" concrete mix design, sampling and testing, and quality control, and as herein specified.
      a. Strength: 4,000 psi at 28 days.
      b. Air entrainment: Total air contact shall be 6.5 percent by volume.
      c. Slump: 3.5 inches

3.02 SURFACE PREPARATION:

A. General
   1. Remove loose material from compacted subbase surface immediately before placing concrete.
   2. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin work until such conditions have been corrected and area ready to receive curbing.

3.03 FORM CONSTRUCTION:

A. General
   1. Set forms to required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
   2. Check completed formwork for grade and alignment to following tolerances:
      a. Top of forms not more than 1/8 inch in 10 feet.
      b. Vertical face on longitudinal axis, not more than 1/4 inch in 10 feet.
   3. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.

3.04 REINFORCEMENT:

A. General
   1. Locate, place and support reinforcement as shown on detail, unless otherwise indicated.

3.05 CONCRETE PLACEMENT:

A. General
   1. Comply with requirements for mixing and placing concrete and as herein specified.
   2. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
   3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator.

4. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
5. At driveways and other places as directed, the curb shall be depressed so as to give a 1½ inch front face and the ends and top of the depressed section shall be dressed with uniform slope as shown on the plans. Curbing shall be molded in place in sections 6 feet long with provision made at each joint for expansion of 1/8 inch.
6. Where curbing is to be removed or laid adjacent to existing pavement or sidewalks that are to remain, the Contractor shall line cut said pavements or sidewalks to provide a clean, uniform edge with a minimum disturbance to the remaining pavement.

B. Premolded Joints
1. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects. Locate expansion joints at 20 feet o.c. maximum, unless otherwise indicated. Extend joint fillers full-width and depth of joint, recessed 1/2 inch below finished concrete surface. Furnish joint fillers in one-piece lengths for full width being placed. Provide joint sealants at all expansion joints.

C. Molding
1. In molding, the section shall be completely separated by steel sheet templates set perpendicular to the face and top of the curb. These templates shall be 1/8 inch in thickness and not less than 2 inches longer than the depth of curbing. These templates shall be set carefully during the placing of the concrete and allowed to remain in place until the concrete has set sufficiently to hold its shape.

D. Formwork
1. All forms shall be set true to line grade and held rigidly in position. They shall be of metal and such construction that a smooth surface shall be provided. Wood forms may be used only with authorization from the Engineer. On curves, all forms must be bent to meet the required curvature; the use of short chords will not be permitted. All forms shall be cleaned thoroughly and greased or soaped before concrete is placed against them. Forms which have become worn, bent or broken shall not be used.

E. Compaction
1. The concrete shall be compacted by means of an approved immersion type mechanical vibrator of a size and weight sufficient to thoroughly vibrate the entire mass. It shall vibrate at not less than 5,000 impulses per minute. Operational stand-by mechanical vibrators shall be made available for substitution in case of mechanical breakdown during concreting operations. The form shall be left in place at least 24 hours after concrete has set sufficiently so that, when ordered by the Engineer, they can be removed without injury to the curbing.

3.06 CONCRETE FINISHING:

A. General
1. Protect and cure finished concrete curb. Use membrane-forming curing and sealing compound or approved moist-curing methods.

B. Anti-Spalling Treatment
1. A second coat of curing and sealing compound may be used or an anti-spalling compound applied over concrete cured by continuous moist curing methods. Apply compounds to concrete surfaces no sooner than 28 days after placement to clean, dry concrete free of oil, dirt and other foreign material. Apply curing and sealing compound at a maximum coverage rate of 300 square feet per gallon. Apply anti-spalling compound in two sprayed applications. First application at rate of 40 square yards per gallon; second application, 60 square yards per gallon. Allow complete drying between applications.

3.07 REPAIRS AND PROTECTIONS:

A. General
1. Repair or replace broken or defective curbing, as directed by Owner's Representative.
2. Drill test cores where directed by Owner's Representative when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory curbing with Portland cement concrete.
3. Protect concrete from damage until acceptance of work. Exclude traffic from curbing for at least 14 days after placement. When construction traffic is permitted, maintain curbing as clean as possible by removing surface stains and spillage of materials as they occur.
4. Sweep curbing and wash free of stains, discolorations, dirt and foreign material just prior to final inspection.

END OF SECTION 32 16 00

SECTION 32 32 23

SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes multiple depth segmental retaining walls with and without soil reinforcement.

B. Related Sections:

1. Division 31 Section Earthwork for excavation for segmental retaining walls.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Provide design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls**.**

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
2. Superimposed loads surcharge indicated on Drawings.

1.04 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
1. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For concrete units.

C. Samples for Verification: For each color and texture of concrete unit required. Submit full-size units.

D. Delegated-Design Submittal: For segmental retaining walls 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. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

E. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.

1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall approximately 72 inches long by not less than 36 inches high above finished grade at front of wall.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.01 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

2. Provide units that comply with requirements for freeze-thaw durability.

B. Color: As selected by Engineer from manufacturer's full range.

C. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

D. Shape and Texture: Provide units of any basic shape and dimensions that will produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with split textured.

E. Batter: Provide units that offset from course below to provide at least 1:5 batter.

F. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.

G. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

2.02 INSTALLATION MATERIALS

A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

C. Leveling Base: Comply with manufacturer’s recommendation and Design Engineer’s requirements

D. Drainage Fill: Comply with manufacturer’s recommendation and Design Engineer’s requirements.

E. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 sieve, 0 to 60 percent passing No. 40 sieve, 0 to 35 percent passing No. 200 sieve, and with fine fraction having a plasticity index of less than 20.

F. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd.

G. Subdrainage Pipe and Filter Fabric: Comply with requirements in Division 33 Section "Subdrainage."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
4. For units with pins, install pins and align units.

E. Cap Units: Place cap units and secure with cap adhesive.

3.03 FILL PLACEMENT

A. General: Comply with requirements in Division 31 Section "Earth Moving," NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Division 31 Section "Earth Moving."

D. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches wide behind drainage geotextile to within 12 inches of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated**,** sloped not less than 0.5 percent to drain.

F. Place impervious fill over top edge of drainage fill layer.

G. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.

H. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.04 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Division 31 Section "Earth Moving" for field quality control.
1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length.

3.06 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

2. Broken, chipped, stained, or otherwise damaged units.
3. Segmental retaining walls that do not match approved Samples.
4. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 23

SECTION 32 33 00

SITE FURNISHINGS

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. The scope of work intended under this section includes furnishing and installation of the site furnishings including their related items necessary to complete the work as shown on, o ras may reasonably be inferred from, the drawings and as described in the specification. Such work shall include but is not necessarily limited to the following:

1. Moon Courtyard Sculpture
2. Sun Courtyard Sculpture
3. Fire Bowl
4. Birdbath
5. Accessible Game Table
6. Game Table
7. Bench with Back
8. Courtyard Chair

1.3 SUBMITTALS

A. Shop drawings, manufacturers and test data, or cut sheets shall be provided for the following:

1. Moon Courtyard Sculpture
2. Sun Courtyard Sculpture
3. Fire Bowl
4. Birdbath
5. Accessible Game Table

6. Game Table

7. Bench with Back

8. Courtyard Chair

B. Shop drawings and/or manufacturer's product literature and data must include the following:

1. A complete list of items and accessories proposed to be furnished. Manufacturer's specifications, catalog cuts and data to demonstrate compliance with these specifications. Submit manufacturer's product data, storage and handling requirement and recommendations, installation methods and available colors, styles, pattern and textures.

2. Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.

3. Submit manufacturer's samples of materials, finishes and colors.

4. Warranty: Manufacturer's standard warranty.

1.4 MATERIALS AND CERTIFICATES

A. Provide three (3) copies of the materials certificates, signed by the material producer and the Contractor, certifying that each material item meets or exceeds specified requirements.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the material of this section before, during and after installation and to protect the installed work and materials of all other trades.

B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

C. Storage: Store materials in a clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.

D. Handling: Protect materials and finish during handling and installation to prevent damage.

E. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Landscape Architect, and at no additional cost

PART 2 - PRODUCTS

2.1 MOON COURTYARD SCUPLTURE

A. Bite Sculpture shall be as manufactured by David Harber LTD, Blewburton Barns, Hasbourne Road Aston Upthorpe, Oxfordshire OX11 9EE, tel: 01235 859 300, www.davidharber.com or approved equal. Sculpture to be marine grade, mirror polished stainless steel and Verdigris copper, on a concrete slab.

B. Provide all mounting hardware as required to secure sculpture.

2.2 SUN COURTYARD SCULPTURE

A. Filium Sculpture shall as manufactured by David Harber LTD, Blewburton Barns, Hasbourne Road Aston Upthorpe, Oxfordshire OX11 9EE, tel: 01235 859 300, www.davidharber.com or approved equal. Sculpture to be marine grade, mirror polished stainless steel.

B. Provide all mounting hardware as required to secure sculpture.

2.3 FIRE BOWL

A. Fire Bowl shall be as manufactured by WoodlandDirect, 235 E. Main Street, Ontario, California 91761, www.woodlanddirect.com, tel: 844-310-1893 or approved equal. Fire Bowl shall be natural gas with electric ignition.

B. Provide all mounting hardware as required to secure fire bowl.

2.4 BIRDBATH BOWL

A. Concept Birdbath shall be as manufactured by Campania International, 2452 Quakertown Rd, Suite 100 Pennsburg, PA 18073, https://www.campaniainternational.com/, tel: 215-541-4627 or approved equal. Birdbath Bowl shall be Australian bronze.

B. Provide all mounting hardware as required to secure birdbath.

2.5 ACCESSIBLE GAME TABLE

A. Game table to be 42” diameter dining height, as manufactured by Landscape Forms, 7800 E. Michigan Avenue, Kalamazoo MI, 49048, tel: (800) 430-6209, www.landscapeforms.com or approved equal. Game Table to be powder coated steel and surface mounted.

B. Provide all mounting hardware as required to secure game table to various pavement types.

2.6 GAME TABLE

A. Game table to be 42” diameter dining height, as manufactured by Landscape Forms, 7800 E. Michigan Avenue, Kalamazoo MI, 49048, tel: (800) 430-6209, www.landscapeforms.com or approved equal. Game Table to be powder coated steel and surface mounted.

B. Provide all mounting hardware as required to secure game table to various pavement types.

2.7 BENCH WITH BACK

A. Bench with back to be the Avondale steel loop end with Ipe hardwood seat slats, as manufactured by Sitescapes Inc., or approved equal. Finish and color shall be as noted on drawing.

B. Provide all mounting hardware as required by manufacturer

2.8 COURTYARD CHAIR

A. Courtyard chair shall be the Avondale backed chair with armrests and Ipe hardwood seat slats, as manufactured by Sitescapes Inc., or approved equal. Finish and color shall be as noted on drawing.

B. Provide all mounting hardware as required by manufacturer

PART 3 - EXECUTION

3.1 EXAMINATION

A. Furnish and install where and as shown on the drawings, in the quantities shown.

B. Comply with manufacturer's recommendations for installation and approved submittals.

END OF SECTION 32 33 00

SECTION 32 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the metal fabrications work as indicated on the drawings and/or specified herein, including but not limited to:

1. Rough hardware
2. Metal Fencing
3. Shade Structure

1.3 RELATED SECTIONS:

A. The following Sections contain requirements that relate to this Section:

1.	Site Furnishings	Section 32 33 00
2.	Concrete for Exterior Improvements	Section 32 05 23
3.	Site Carpentry	Section 06 10 10

1.4 QUALITY ASSURANCE

A. Performance Standards for all work included under this section: Conform to New York State Building Code

B. Fabricators and Manufacturers: engage fabricators and manufacturers with a minimum of five (5) years experience fabricating/manufacturing items similar in nature, size scale, use, materials, etc. to those specified herein and shown on contract drawings.

C. Installers: Engage installer(s) with a minimum of five (5) years experience in installing items and work similar in scope to those specified herein and shown on contract drawings.

D. Fabricators, manufacturers and installers shall provide photos of finish and/or in progress work similar to that specified herein and shown on contract drawings for approval by Landscape Architect prior to commencement of work.

E. Field Measurements: Take field measurements prior to the preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

F. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

G. Avoid fabrication techniques that could cause distortion or embrittlement of steel items to be hot-dip galvanized. Fabricator shall consult with hot-dip galvanizer regarding potential warpage problems or handling problems during the galvanizing process that may require adjustment of fabrication techniques or design before finalizing shop drawings and beginning of fabrication.

H. Steel members shall contain a minimum of 25% (combined) post industrial/post consumer recycled content (the percentage of recycled content is based on the weight of the component materials).

1.5 SUBMITTALS

A. General: Refer to and comply with Division 1 Section “Submittals”, for procedures and additional submittal criteria.

1. Coordinate stainless steel fabrications with submittal requirements for clear protective coating.

B. Manufacturer’s Literature: Submit manufacturer’s specifications, load tables, dimension diagrams, anchor details and installation instructions for products to be use din the fabrication of miscellaneous metal work, including paint products.

1. Include certification of recycled content of materials

C. Shop Drawings: Contractor shall provide shop drawings for the fabrication and erection of all metal fabrication assemblies. Include plans and elevations at not less than 1" = 1'-0" scale, and include details of sections and connections at not less than 3" = 1-0" scale. Show anchorage and accessory items. Shop drawings of metal fabricated items to be approved by Landscape Architect prior to commencement of fabrication. Shop drawings shall be provided for, but not limited to, the following:

1. Metal Fencing

2. Shade Structure

D. Engineering Data:

1. Contractor shall submit detailed engineering data drawings to the Landscape Architect for review indicating how performance standards specified shall be met. The Contractor is responsible for the structural design and supports for all metal fabrication systems and must show his proposed systems on these drawings.

2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New York and shall be signed and sealed by this Engineer.

E. Welding shall be indicated on shop drawings using AWS symbols and showing length, size and spacing (if not continuous). Auxiliary views shall be shown to clarify all welding. Notes such as ¼" weld, weld and tack weld are not acceptable.

1. Certifications: Submit certificates for hot-dip galvanized steel items to identify each item galvanized and to show compliance of application. The Certificate shall be signed by the galvanizer and shall contain a detailed description of the material processed and the ASTM standard used for the coating and, the weight of the coating. In addition, and as attachment to Certification, submit reports of testing and inspections indicating compliance with the provisions of this Section.

F. Samples: Contractor shall provide one (1) square ft or 1 ft length minimum size sample for each material type, finish and color metal specified herein and shown on contract drawings. Samples shall include, but not limited to metal materials for the following items:

1. Metal Fencing

2. Shade Structure

PART 2 - PRODUCTS

2.1 MATERIALS

A. Carbon Steel

1. Carbon Plates, Shapes and Bars: ASTM A36

B. Galvanize Repair Coating: For touching up galvanized surfaces after erection, provide Z.R.C. Cold Galvanizing Compound made by Z.R.C. Chemical Products Co. or approved equal.

2.2 GALVANIZING

A. Scope: All carbon steel shall be cleaned and then hot-dipped galvanized after fabrication.

B. Cleaning: Thoroughly clean metal surfaces of all mill scale, rust, dirt, grease, oil, moisture and other contaminants prior to galvanizing.

C. Application: Hot dip galvanizing shall be applied in accordance with:

1. ASTM A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. ASTM A153: Galvanized Coating on Iron and Steel Hardware – Table 1

3. ASTM A924: Galvanized Coating on Steel Sheets

4. ASTM A385: Practice for Providing High Quality Zinc Coatings

5. ASTM A143: Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel

6. Minimum weight of galvanized coating shall be two (2) oz. per square foot of surface

D. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

E. All galvanized materials must be inspected for compliance with these specifications and marked with a stamp indicated the name of the galvanizer, the weight of the coating, and the appropriate ASTM number.

F. To minimize surface imperfection (eg: flux inclusions), material to be galvanized shall be dipped into a solution of Zinc Ammonium Chloride (pre-flux) immediately prior to galvanizing. The type of galvanizing process utilizing a flux blanket overlaying the molten zinc will not be permitted.

G. After galvanizing all materials not exposed to view must be chromated by dipping material in a 0.2% chromic acid solution.

H. Galvanized surfaces, where exposed to view shall be painted, must have a smooth, level surface finish. Where this does not occur, piece shall be rejected and replaced to the acceptance of the Landscape Architect. Color of painted components shall be as shown on drawings and approved by Landscape Architect.

2.3 MISCELLANEOUS METAL ITEMS

A. Rough Hardware

1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures

2. Fabricate items to sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood connections; elsewhere, furnish steel washers.

3. Welded Connections: Fabricate handrails and barrier railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base materials
   b. Obtain fusion without undercut or overlap

c. Remove flux immediately
d. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
e. Form changes in direction of railing members by radius bends
f. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces of handrail and railing components.
g. Close exposed ends of handrail and railing members with prefabricated end fittings.
h. Brackets, Flanges, Fittings, and Anchors: Provide brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work. Furnish inserts and other anchorage devices for connecting handrails and railings to concrete. Fabricate anchorage devices capable of withstanding loads per Code requirements. Pavement Edging Angles

4. Provide pavement edging angles of sizes shown on drawings, minimum 10’ lengths, connections at seams to be fully welded. Entire assembly shall be hot dip galvanized meeting standard specified herein.

2.4 METAL FENCE

A. Manufacturer:

1. Fence system shall be Aero Aluminum Fence as manufactured by Jerith Manufacturing LLC, 14400 McNulty Road, Philadelphia, PA 19154, or approved equal.
   a. Fence shall be Jerith Doria
   b. Nominal fence height of 72”
   c. Color shall be black

B. Materials:

1. Aluminum Extrusions: All posts and rails used in the fence system shall be extruded from HS-35™ aluminum alloy having a minimum yield strength of 35,000 psi. All pickets shall have a minimum yield strength of 25,000 psi. 6063-T5 and -T52 Alloys (in accordance with ASTM B221) are not acceptable for any components.

2. Fasteners: All fasteners shall be stainless steel screws with heads painted to match the color of the fence.

3. Accessories: Aluminum sand and die castings shall be used for all scrolls, post caps, finials, and miscellaneous hardware. Die castings shall be made from Alloy A360.0 as per ASTM B85 for superior corrosion resistance. Alloy A380.0 is not acceptable.

C. Finishes:

1. Pretreatment: A three stage non-chrome pretreatment shall be applied. The first step shall be a chemical cleaning, followed by a water rinse. The final stage shall be a dry-in-place activator which produces a uniform chemical conversion coating for superior adhesion.

2. Coating: Fence materials shall be coated with FencCoat™, a Super-Durable TGIC polyester powder-coat finish system applied by Jerith Manufacturing LLC. Epoxy powder coatings, baked enamel or acrylic paint finishes are not acceptable. The FencCoat finish shall have a cured film thickness of at least 2.0 mils.

3. Tests: The cured finish shall meet or exceed AAMA 2604, which includes the following requirements:
   a. Humidity resistance of 3,000 hours using ASTM D2247.
   b. Salt-spray resistance of 3,000 hours using ASTM B117.
   c. Outdoor weathering shall show no adhesion loss, checking or crazing, with only slight fade and chalk when exposed for 5 years in Florida facing south at a 45 degree angle.

4. Finishes that only meet AAMA 2603 are not acceptable.

D. Fabrication:

1. Horizontal rails shall be 1-1/8" x 1½" channels formed in a modified "U" shape with rounded edges. Pickets shall pass through holes punched in the top of the rail. The top wall shall be .060" thick and the side walls .070" thick for superior vertical load strength. There shall be [2 (for Sentry only), 3, 4 (for 72" tall only)] horizontal rails in each section.

2. Pickets shall be fastened to the rails using stainless steel screws on one side of the rail. Pickets shall be 1" x 5/8" with rounded corners and have a wall thickness of .050". Welding the pickets to the rails is not permitted.

3. Posts shall be 2½" x 2½" extrusions with rounded corners and pre-punched holes which allow the fence section rails to slide in. Posts shall be spaced [71" (for Sentry), 100¾"] on center and have .075" walls. Gate posts shall be [2½", 4"] square with .125" walls and used on both sides of a gate. Die cast aluminum caps shall be provided with all posts.

4. Assembled sections shall support a 300 lb. vertical load at the midpoint of any horizontal rail.

E. The entire fence system shall have a written Limited Lifetime Warranty against rust and defects in workmanship and materials. In addition, the FencCoat finish shall be warranted not to crack, chip, peel, or blister for the same period.

2.5 SHADE STRUCTURE

A. Contractor shall install shade structures as shown on contract drawings.

B. Layout and arrangement shall be shown on contract drawings.

C. Description of Product:

1. Building Type: Curved MIL 12x35

2. Roof Slope: 1.5/12

3. Minimum Clearance Height (MCH): 7’-6”. Minimum clearance height under the structure indicates the lowest height of a member from finish grade for clearance under the structure. This is generally the clearance under roof eave or frame, whichever is lower.

D. Manufacturers

1. Acceptable Manufacturer: Poligon, a Product of PorterCorp, 4240 N 136th Ave., Holland, MI 49424; 616.399.1963, or approved equal.

E. Materials:

1. GENERAL: The pre-engineered package shall be pre-cut unless otherwise noted and pre-fabricated which will include all parts necessary to field construct the shelter. The shelter shall be shipped knocked down to minimize shipping expenses. Field labor will be kept to a minimum by pre-manufactured parts. Onsite welding is not necessary.

2. Reinforcing shall be ASTM A615, grade 60

3. STEEL COLUMNS
   a. Hollow structural steel tube minimum ASTM A500 grade B with a minimum wall thickness of 3/16”.
   b. Unless columns are direct buried, columns shall be anchored directly to concrete foundation with a minimum of four anchor rods to meet OSHA requirement 1926.755(a)(1).

4. STRUCTURAL FRAMING: Hollow Structural Steel tube minimum ASTM500 grade B. “I” beams, tapered columns, or open channels shall not be accepted for primary beams. Frame will have a STANDARD POLI-5000 finish. Color chosen from manufacturer’s standard color chart.

5. COMPRESSION MEMBERS: Compression rings of structural channel or welded plate minimum ASTM A36 or compression tubes or structural steel tube minimum ASTM A500 grade B shall only be used.

6. CONNECTION REQUIREMENTS:
   a. Anchor bolts shall be ASTM F1554 (Grade 36) unless otherwise noted.
   b. Structural fasteners shall be zinc plated ASTM A325 high strength bolts and A563 high strength nuts.
   c. Structural fasteners shall be hidden within framing members wherever possible.
   d. No Filed welding shall be required to construct the shelter
   e. All welds shall be free of burrs and inconsistencies.
   f. Exposed fasteners shall be powder coated by manufacturer prior to shipment to match frame or roof colors as applicable.
   g. Manufacturer shall provide extra structural and roofing fasteners.

7. FINISHES:
   a. STANDARD POLI-5000 FINISH:
      1) Steel shall be cleaned, pretreated, and finished at a facility owned and directly supervised by the manufacturer

2) Steel Shall be shot blasted to SSPC-SP10 near-white blast cleaning. SSPC-SP2 hand tool cleaning will not be an acceptable alternative.
3) Parts shall be pretreated in a (3) stage iron phosphate or equal washer.
4) Epoxy primer powder coat shall be applied to parts for superior corrosion protection.
5) Top coat of Super Durable TGIC powder coat shall be applied over the epoxy primer.
6) Finish shall not have VOC emissions.
7) Sample production parts shall have been tested and mee the following criteria:
   a) Salt spray resistance per ASTM B 117/ASTM D 1654 to 10,000 hours with no creep from scribe line and rating of 10.
   b) Humidity resistance per ASTM D2247-02 to 5,000 hours with no loss of adhesion of blistering.
   c) Color/UV resistance per ASTM G154-04 to 2,000 hours of exposure, alternate cycles with results of no chalking, 75% color retention, color variation maximum 3.0 E variation CIE formula (before and after 2,000 hours exposure).
8) The manufacturer shall be PCI 4000 S Certified
9) Exposed fasteners for frame and ornamentation shall be powder coated to match structure

PART 3 - EXECUTION

3.1 INSTALLERS STORAGE AND HANDLING

A. Protect building products after arrival at destination from weather, sunlight, and damage

B. Installer shall store product elevated to allowed air circulation and to no introduce mold, fungi decay or insects to the product

C. Product must be handled with protective straps or padded forks if lifting with mechanical equipment. Use of chain or cable to lift product into place will not be accepted and may void manufacturer’s warranty

3.2 ERECTION

A. INSTALLATION: The fencing and shade structure shall be erected by a Certified Installer who has a demonstrated ability to construct the items in the manner recommended by the manufacturer’s instructions.

B. GENERAL CONTRACTOR: Interface with other work is to be coordinated by the customer or the customer’s agent. Certain designed have electrical or other plumbing requirements that are not supplied by Poligon.

C. TOLERANCES: Tolerances on steel structural members are set according to AISC construction practices, abided in the factory, and cannot be increased. No field slotting or opening of holes will be allowed. It is therefore essential that contractors conform to the tolerances specified on the installation drawings for anchor bolt or column layout details.

D. OSHA COMPLIANCE: OSHA Compliance to Steel Erection Standard 29CRF 1926 Subpart R-Steel Erection.

3.3 INSPECTION

A. Examine the areas and conditions where metal fabrications are to be installed and correct any conditions detrimental to them properly, with a timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.4 REPAIR

A. Do not attempt any field changes without first contacting manufacturer.

END OF SECTION 05 50 00

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SECTION 32 90 00

PLANTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Site Improvement: Section 32 90 00

1.2 SUMMARY

A. The scope of work intended under this contract includes furnishing all labor, materials, tools and equipment for planting and related work necessary to complete the work as shown, or as may be reasonably inferred from, the drawings and as described in the Specifications. Such work shall include but is not necessarily limited to the following:

1. Furnish and install topsoil and planting soil mixes
2. Furnish and install soil amendments
3. Furnish and install plant materials
4. Furnish and install seeded and sodded lawn
5. Maintenance, inspection, guarantee, and replacements

B. Subgrade Elevations: Excavation, filling and grading required to establish elevations shown on the drawings are specified under other sections of these specifications.

C. Related Sections include the following:

1.	Irrigation	Section 32 84 00

1.3 QUALITY ASSURANCE

A. General: Furnish certificates of inspection of landscape materials, to accompany shipments. Comply with all applicable regulations governing landscape materials.

B. Plants: Provide nursery grown plants grown in a recognized nursery in accordance with good horticultural practices. Provide only healthy, vigorous stock grown under climatic conditions similar to conditions in the locality of the project, and free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions or disfigurement.

C. Qualifications For Inspecting and Testing Horticultural Materials: Qualifications of Contractor's Agricultural Chemist / Testing Laboratory / Agency shall be submitted to and approved by Landscape Architect prior to start of procurement of soil materials and earthwork operations on Project.

1. Agricultural Chemist: Experienced person or persons employed by public or private soils testing laboratory, qualified and capable of performing tests, making soil recommendations, and issuing reports as specified herein.

2. Soils Testing Laboratory: An independent laboratory with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed and capable of making soil recommendations, and issuing reports as specified herein.

D. Inspections and Testing of Horticultural Soil Materials:

1. Material Testing: Contractor shall engage and pay for the services of a qualified Agricultural Chemist / Soils Testing Laboratory / Agency to perform all material testing and inspections of Project related horticultural soils, organic materials and other material testing and soil mix material testing required in this Section or additionally required by the Landscape Architect and/or Construction Manager.

a. Acceptable Planting Soil Materials Testing Laboratories:

(a). Nutrient Testing Laboratories, Ltd.
DBA Chemical Consulting of Babylon
41 East Main Street, Babylon Village, New York 11702
(631) 587 0632 – phone; (631) 587 0827 – fax

(b). Turf & Soil Diagnostics - NY
35 King Street, P.O. Box 606, Trumansburg, NY 14886
(855) 769 4231 – phone; lab@turfdiag.com – email

(c). Rutgers Soil Testing Laboratory
1) Rutgers, The State University of New Jersey
2) 57 US Highway 1
3) New Brunswick, NJ 08901-8554
4) Phone: 848-932-9295
5) Email: soiltest@njaes.rutgers.edu

2. Horticultural planting soil materials, material replacements, and soil amendments materials shall be subject to quality control inspections and testing by Contractor's Testing Laboratory / Agency as specified or, if questionable conditions, additionally directed by the Landscape Architect and/or Construction Manager.

a. Tests of imported (borrow) material shall be made prior to borrow material delivery with test reports submitted and approved by Landscape Architect prior to material delivery or use on site.

(a). A minimum of 5 tests shall be made from samples taken at random at each material source with report submitted of each analysis. Landscape Architect and/or Contractor's Testing Laboratory / Agency may, at their discretion, direct random selection at source.

i. Each Base Soil Material Component, each source, minimum 50 lb. packaged.
ii. Compost material, each source, minimum 50 lb.

packaged.

iii. Each soil mix type specified, minimum 50 lb. packaged.

(b). Samples of individual components of planting soil mixes shall be submitted to the approved testing laboratory and all test results shall be submitted to and approved by the Landscape Architect prior to the start of planting soil mixing.

(c). Samples of all blended soil mixes shall be submitted to the approved testing laboratory and all test results shall be submitted to and approved by the Architect prior to delivery of any planting soil mixes or materials to the site.

(d). Tests of all Soil Mix stockpiles at the off-site soil mixing location mixes shall be submitted to the approved testing laboratory and all test results shall be submitted to and approved by the Landscape Architect each time a stock pile of soil mix is created and prior to site delivery. Stockpile size limited to a maximum of 500 cubic yards.

b. Tests of material as delivered on site will be required to be made from time to time, the circumstance and extent of which shall be subject to approval or direction of Landscape Architect and/or Construction Manager based on the following:

(a). One (1) fifty pounds (50-lbs.) bag sample for quality control confirmation testing of horticultural soil materials shall be taken at random from haul trucks for, as a minimum, each 500 (Five hundred) cubic yards of material delivered to site for placement. Sample shall be identified with copy of truck delivery slips containing pertinent information of source and type as approved.

(b). Samples taken shall be laboratory tested and reports made as specified for soil analysis of respective material in Part 2 herein to confirm compliance with or note discrepancy from previously approved material testing and Soil Certifications and Analysis of materials at source.

c. Contractor shall cooperate in obtaining samples of materials for testing and shall furnish incidental off-site and field labor in connection with any tests.

d. Materials in question shall not be used, pending test results of conformance to specified requirements.

3. Materials in question shall not be used, pending test results of conformance to specified requirements.

1.4 SUBMITTALS

A. Submit two (2) copies of certificates of inspection as required to accompany shipments. Submit manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

B. Contractor shall submit plant design layout for all bioretention, rain garden and stormwater planters for Landscape Architect's approval prior to planting.

C. Soil Submittal Requirements:

1. Qualifications: Submit qualifications and resume of Contractor's Agricultural Chemist / Soils Testing Laboratory proposed to be utilized for soil material testing.

2. Product Data:

a. Submit technical descriptive data for each manufactured or packaged product of this Section. Include manufacturer's product testing and analysis and installation instructions for manufactured or processed items and materials. Include guaranteed analysis and weight of pre-packaged material as specified for certification of material not pre-packaged.

b. Locations: Submit locations of soil mix material sources. Submit location of soil mixing sites.

3. Samples: Allow sufficient time for submittal review and confirmation testing and evaluation of material test results by the Landscape Architect before start of material procurement.

2. a. For Testing: Submit samples of each type soil and organic matter material specified from the proposed source of supply as required for testing (Soil Certification and Analysis) specified herein and for confirmation review of characteristics.

a. 1) Submit samples for testing directly to testing laboratory/agency, a bagged minimum quantity indicated for each test clearly identified for each material type and each source and with copy of transmittal and material type identification to the Construction Manager.

b. 2) Submit additional quantities if requested.

c. 3) Certification and analysis of horticultural soil materials and amendment materials shall be documented and reported based on testing by a licensed independent agricultural testing laboratory engaged by Contractor using material samples proposed for Project Work and as specified herein. See Article "Quality Assurance" herein for additional criteria.

3. b. For Quality Control: Other soil samples shall be submitted as requested by Landscape Architect or Construction Manager or allowed to be taken as required for quality control services by Owner's separately engaged Testing Laboratory.

4. c. For Verification Review:

a. 1) Soils: For visual characteristics, submit to the Landscape Architect, 1 Gallon bag, clearly identified for each type soil, and organic matter (compost), Submit from each source if any material from multiple sources.

4. Test Reports:

a. Submit agricultural material test reports as specified herein for confirmation of each soil type, soil mix design, and for field quality control. Submit in compliance with the following sequence:

(a). Prior to Preparation of Soil Mixes: Submit Component Material Test Reports.

(b). Prior to Soil Delivery to Site: Submit Soil Mix Test Reports including physical tests, pH and organic analysis as specified herein.

(c). After Placement of Soils on Building: Submit as work is performed.

b. Submit agricultural test report(s) for each horticultural soil material sample tested of material obtained from off-site sources. In testing and analysis reports, use the test criteria specified herein. Failure to include any of the stated criteria will be sufficient cause for rejection of the test reports.

c. Use test reports and format indicted by Sample Test Report Forms attached to the end of this Section. Each test report shall include the following as a minimum and such other information required specific to the material tested:

(a). Date Issued.

(b). Project Title and names, addresses and telephone number(s) of Contractor and material supplier, and soil type or soil mix tested.

(c). Testing laboratory name, address and telephone number, and name(s) as applicable, of each field and laboratory inspector.

(d). Date, place, and time of sampling or test, with record of temperature and weather conditions.

(e). Location of material sampling source.

(f). Type of test including ASTM reference and/or description of testing parameters used.

(g). Particle size analysis/distribution as defined below as well as by hydrometer method.

(h). Particle size analysis including gradation(s) indicated by sample test report form(s).

(i). Cation exchange capacity.

(j). Results of tests including identification of deviations from acceptable ranges. Identify any toxic substance(s) harmful to plant growth or life.

(k). Organic matter content.

(l). Hydrometer Test describing percentage of sand, clay, and silt.

(m). pH, Buffer pH, soluble salts and C:N ratio.

5. Certificates:

a. Submit certified analysis for each soil treatment and amendment material to be used and not submitted as Product Data pre-packaged material with labeled documentation of analysis acceptable to Architect. Include guaranteed analysis and weight of material as delivered to site of work. Analysis shall be by a recognized laboratory according to methods established by the Association of Official Agricultural (Analytical) Chemists.

b. Certificate of Supply: Upon delivery of Soils to Project Site include Certificate of Supply together with Supplier material tickets for each planting soil load delivered to site.

c. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

d. Warranty Documentation: Submit manufacturer's standard warranty.

e. Submit grower's certificate of grass seed mix including percentage by weight of each species.

f. Submit grower's certificate of sod mix including percentage by weight of each species.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at the site.

B. All plants shall be packed, transported, and handled with utmost care to insure adequate protection against injury.

C. Plant material is to be delivered to the site in quantities and at the dates established in consultation with the Landscape Architect. If trees are delivered to the site before said date they shall be properly protected against the drying action of the sun and wind. Earthballs shall be mulched with salt hay and thoroughly watered at least once daily. Proper care as outlined above, shall be taken of any plant stored on the site for more than twelve hours. The Landscape

Architect shall be notified at least 72-hours in advance of the arrival of plant material at the site in order to permit a mutually satisfactory date for its placement.

1.6 JOB CONDITIONS

A. Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

B. Cooperate with other contractors and trades working in and adjacent to the landscape work areas. Examine drawings which show the development of the entire site and become familiar with the scope of other work required.

C. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate as required, to minimize possibility of damage to under ground utilities and roots of plants to remain. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

D. Planting Schedule: Submit to the Landscape Architect for review, a proposed schedule. Schedule each type of landscape work required during the normal season for such work in well defined areas of the site. Give dates for each type of work and establish a completion date. Correlate with specified maintenance periods to provide maintenance until occupancy by the Owner. Once accepted by the Landscape Architect, subsequent modifications must be approved in writing.

E. Environment Requirements:

1. During Cold Weather:

a. Do not use frozen materials.

b. Do not use materials mixed or coated with ice or frost.

2. During Wet Weather: Do not plant on wet, saturated, or muddy subgrade.

PART 2 – PRODUCTS

1. SCREENED TOPSOIL

A. Screened topsoil shall consist of natural topsoil structure and tilth. It shall not be mixed with subsoil and shall be obtained from an area which has not previously been stripped of topsoil. It shall not be removed to a depth of over one (1) foot, if, in the opinion of the Landscape Architect, the subsoil is encountered before this depth is reached.

B. The physical characteristics of the topsoil shall indicate uniform color, texture, and tilth so as to constitute a homogeneous product that will meet the requirements of these specifications. It shall be free from any objectionable materials, such as stones over one (1) inch in size, hard clods, stiff clay, sods, hard pan, partially disintegrated rock, stone or other materials, that are not integrally a natural component of good soils, and that are harmful or unnecessary to plant growth.

C. Certification: Furnish a certified laboratory report showing the mechanical analysis, the organic content and acidity of representative samples of the topsoils before delivery of the material. Samples of the topsoil are to be taken by the Contractor's Representative with the Owner's representative present.

D. Bring the samples to a laboratory approved by the Owner and Landscape Architect; engaged by the Contractor and paid for by the Contractor.

E. Tests: No topsoil shall be delivered in a frozen or muddy condition. The topsoil shall comply with the following requirements:

1. Organic Matter: (By the Dichromate Oxidation Method) 8.0% to 10.0% minimum by weight, based on the weight of the sample dried to constant weight at 100 to 110 degrees C. Soil will be tested for organic matter by use of a No. 40 mesh sieve (0.420 millimeters or .0165 inches).

2. Acidity: The acidity shall be within the range of (6.0) pH and (7.5) pH.

3. Sieve Analysis: (By wash test, ASTM DESIGNATION C 117)

Passing	Percentage
1" Sieve	97% to 100%
4 Sieve	90% to 100%
#100 Sieve	30% to 60%
#200 Sieve	10% to 30%

4. The proportion of sand to that of very fine sand, silt and clay may be changed by the Landscape Architect if the existing conditions on the site where the top soil is to be used warrant such a change. Any topsoil whose content of either clay or sand is over 60%, may be rejected at the discretion of the Owner and/or Landscape Architect. All percentages are to be based on dry weight of the sample.

5. All samples for Testing are to be taken from parcels of land before the topsoil is stripped or "bulldozed". The Owner's Representative reserves the right to reject for sampling all soils stored in windrows or stockpiles.

6. Number of Tests: There shall be one test taken for every 30-40 cubic yards of topsoil to be delivered to the site.

7. No topsoil shall be delivered until the samples are approved by the Landscape Architect. Such approval shall not constitute final acceptance, however, if subsequent tests, taken after topsoil is delivered to the site of operation, show a deficiency of not more than 5% in organic matter. Add acceptable humus, peatmoss, or other soil in sufficient quantities to raise the organic matter content of the topsoil to 5 % by weight. If topsoil delivered to the site tests less than 5% organic, based on the Dichromate Oxidation Method of Laboratory Analysis it shall be removed from the site at the discretion of the Owner's Representative.

8. The rate of adding approved soil amendment to the topsoil shall be one cubic yard per 18 cubic yards of topsoil for each 1% of organic matter deficiency.

9. Soluble salts range equal to or less than 1500 micromhos per centimeter.

10. This shall be used for all topsoil applications.

2.2 SOIL AMENDMENTS

A. Manure: Manure shall be dehydrated manure such as 3 Manure Blend by Mine Mountain Organic Farm, Inc., Bovung, or equal.

B. Compost: Compost shall be by NaturCycle, LLC, PO Box 97, Plainville, NY 13137, or approved equal. Compost shall contain organic matter, or material of generally humus nature capable of sustaining the growth of vegetation, with no admixture of refuse or materials toxic to plant growth. The compost shall be free of pathogens and stones, lumps, or similar objects larger than two inches (2") in greater diameter, as well as roots, brush and weeds.

Composts that have been derived from organic wastes such as food and agriculture residues, animal manures, composted leaves that meet the above requirements, and are approved by New Jersey State DEP, are acceptable compost sources. Compost shall have an approximate N-P-K analysis of at least 1-1-0 as deliverable, with a pH between 5.5 and 8.0 and a solids content of at least fifty percent (50%). Compost shall have minimum of twenty five (25%) to a maximum of seventy five percent (75%) organic materials. Soluble salts shall be less than 6.00 mmhos/cm. Moisture content shall be 20-65%.

Compost shall have undergone mesophilic and thermophilic temperatures to reduce viability of pathogens and weed seeds. Compost shall demonstrate involvement in the US Composting Seal of Testing Assurance (STA) Program via a certified independent analysis as provided by a laboratory participating in the STA program. A recent (within 90 days of project start) STA Technical Data Sheet is required to be submitted prior to shipment of compost.

Organic biosolids are not acceptable under this specification.

C. Lime: Lime shall be ground dolomitic limestone not less than 85% total carbonated, ground so that 50% passes 100 mesh sieve and 90% passes 20 mesh sieve. Amount of lime shall be determined by the soil test and the plant requirements.

D. Superphosphate - 0-20-0: As manufactured Lebanon Chemical Co., P. O. Box 180, Lebanon, PA 17042, or approved equal, conforming to the following:

1. Formulated fertilizer having a guaranteed analysis as follows:

0% N
20% $P_2 0_5$
0% $K_2 0$

E. Commercial Fertilizer for Planting: Commercial fertilizer shall be a complete fertilizer, part of the elements of which are derived from organic sources, and shall contain the following percentages by weight: nitrogen 5%; phosphoric acid 10%; potash 5%. It shall be uniform in composition, dry, free flowing, and shall be delivered to the site in the original unopened containers all bearing the manufacturer's guaranteed analysis. Percentages shall be adjusted at the discretion of the Landscape Architect, if soil tests so indicate.

F. Commercial Fertilizer for Lawns: Commercial fertilizer shall be a complete fertilizer, part of the elements of which are derived from organic sources, and shall contain the following percentages by weight: nitrogen 20%; phosphoric acid 10%; potash 5%. It shall be uniform in composition, dry, free flowing, and shall be delivered to the site in the original unopened containers all bearing the manufacturer's guaranteed analysis. Percentages shall be adjusted at the discretion of the Landscape Architect, if soil tests so indicate.

G. Herbicide: Herbicide shall be equal to Balam, manufactured by Elanco Products Corp., a division of Eli Lilly & Co., Indianapolis, Indiana 46206. Product is a selective preemergence herbicide for the control of crabgrass and other annual weed grasses. Product shall be used in planting beds.

H. Antidesiccant: Shall be polyvinyl type, the product name, manufacturer, instructions for use shall be submitted to the Landscape Architect prior to application of the selected plant materials.

I. Bark Mulch: Shredded hardwood bark mulch. Shall not exceed 3" in length and 1" in width. Shall be free of leaves, twigs or other debris.

J. Water: Water suitable for irrigation will be the responsibility of the Contractor. Comply with all current water use regulations in effect at time of installation.

2.3 TOPSOIL MIXTURES

A. Deciduous Plants: Topsoil mixture for backfilling planted areas shall consist of four parts by volume of topsoil thoroughly mixed with one part of compost.

B. Evergreen Plants: Topsoil mixture for backfilling planted areas shall consist of three parts by volume of topsoil thoroughly mixed with one part of compost.

2.4 MULCH

A. Shredded hardwood bark mulch. Shall not exceed 3" in length and 1" in width. Shall be free of leaves, twigs or other debris. Mulch shall be derived from tree material, not from wood waste or by-products like sawdust, shredded palettes, or other debris. Mulch shall be natural in color and not dyed. It shall be of a uniform grade with no additives or any other treatment.

2.5 FERTILIZER

A. Commercial Fertilizer: Fertilizer shall be slow release and shall have the following composition:

1. Nitrogen (N) 7% - 10%, minimum 50% slow-release

2. Available Phosphorus (P) 1% - 2%

3. Soluble Potash (K) 4% - 12%

B. Fertilizer shall be pesticide free (no weed-and-feed type) product such as "Healthy Turf (8-1-9)" as manufactured by Plant Health Care, Inc, Pittsburgh, PA; or Safer Ringer Lawn Restore (10-2-6) as manufactured by Woodstream Corp., Lifitz, PA; or Nutrients Plus (7-2-12) as manufactured by Nutrients Plus, Virgnia Beach VA, or approved equal.

C. All Commercial Fertilizer Low Phosphorous (Slow Release) shall be delivered in standard size bags of the manufacturer, showing weight, analysis, and name of manufacturer.

2.6 LIMESTONE

A. Ground Limestone (Calcium Carbonate) shall have the following analysis: at least fifty percent (50%) shall pass a 200 mesh sieve, at least ninety percent (90%) shall pass a 100 mesh sieve, and one hundred percent (100%) shall pass a ten (10) mesh sieve.

Total carbonates shall not be less than eighty percent (80%) or 44.8% Calcium Oxide equivalent. For purposes of calculation, limestone may be substituted at the discretion of the Engineer, when wind conditions exceed five (5) miles per hour. The Contractor shall, at the direction and discretion of the Engineer, furnish a certified report of chemical analysis of representative samples of the limestone which he proposes to use. All sampled are to be taken by the Engineer and delivered to the laboratory; the price bid shall include inspection and laboratory charges. No limestone shall be delivered until the approval of sampled by the Engineer, but such approval does not constitute final acceptance of the material. The Engineer reserves the right to reject, on or after delivery, any material which does not, in their opinion meet these specifications.

The rate of application of limestone per thousand (1,000) square feet shall be as follows, depending on the Hydrogen Ion concentration (pH) shown by a pH test (pH test to be provided by the Contractor at no additional cost to the Owner).

pH	Rate (LBS.)
Below 5.0	160
5.0 to 6.0	80
Over 6.0	0

All limestone shall be delivered in standard size bags of the manufacturer showing weight, analysis, and name of the manufacturer. It shall be stored in such a manner that its effectiveness will not be impaired, as directed by the Engineer.

2.7 PLANT MATERIAL AND RELATED APPURTENANCES

A. Plant List: Plant material shall conform to the Standard Specifications of the "American Standard for Nursery Stock", sponsored by the American Association of Nurserymen, Inc. All plants shall be grown under climatic conditions similar to the job site areas for a period of not less than two (2) years immediately prior to installation on this project.

B. Substitutions: No substitutions shall be accepted, except with the written permission of the Landscape Architect.

C. Quantities, Quality, and Size

1. Furnish quantities necessary to complete the planting as shown and located on the Planting Plan(s) of the contract drawings. Plants shall be sound, free, healthy, vigorous, free from insects, plant diseases and injuries. All plants shall equal or exceed measurements specified in the plant list which are the minimum acceptable. No plants shall be pruned or clipped prior to delivery except with the permission of the Landscape Architect.

2. Plant material in the nursery will be approved by the Landscape Architect by means of a site inspection or the submission of photographs by the nurserymen prior to delivery to the job site. All photos must indicate the scale of the plant material by means of the human subject and yardstick, etc.

3. Collected plant material shall not be used.

2.8 SEED LAWN

A. Grass seed shall be fresh, recleaned seed of the latest crop mixed in the following proportions by weight and meeting the following standards of pure live seed content. The tolerance of P.L.S.

(purity x germination) shall be those called official and tabulated on Page 5, Department of Agriculture Bulletin No. 480.

B. Lawn Materials: Seeding of permanent lawn shall be done with a seed mix composed of seeds mixed in the proportions by weight and testing the minimum percentages of purity as follows:

Percentage	Proportion by Weight
20%	A variety of Kentucky Bluegrass
20%	A variety of Perennial Ryegrass
60%	A blend of a minimum of 3 varieties of Tall Fescues

2.9 SOD LAWN

A. Sod shall be a superior sod grown from high quality seed of known origin. Seed is to be inspected by a Certification Agency to assure satisfactory genetic identity and purity, overall high quality, and freedom from noxious weeds at time of harvest.

B. The blend/mix of grass in sod shall be one of those listed below and shall be harvested from one field to insure a uniform color and texture.

C. Percentages of each grass type are to be as specified under 2.8, GRASS SEED.

D. Sod shall be machine cut to uniform soil thickness of five-eighths inch (5/8”), plus or minus one-quarter inch (1/4”) at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut eighteen inches (18”) wide by sixty inches (60”) long (7-1/2 sq. ft.) or rolls four feet (4’) wide by fifty feet (50’) long (200 sq. ft.). Standard sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically. Sod shall not be harvested or transplanted when the moisture content may adversely affect its survival. Sod shall be harvested, delivered, and transplanted within a period of thirty six (36) hours. Before cutting, sod shall be mowed uniformly at a height of one and one-half inches (1-1/2”).

3.2 BUTTERFLY MEADOW SEED MIX

A. Butterfly meadow seed mix shall be “Butterfly and Hummingbird Garden Mix” as produced by Ernst Seeds or approved equal.

1. Item Number: ERNMX-179

2. Seeding Rate: 7-10 lb per acre with 30 lbs/acre of a cover crop. For a cover crop use either grain oats (1 Jan to 31 Jul) or grain rye (1 Aug to 31 Dec).

3.3 MEADOW SEED MIX

A. Meadow seed mix shall be “FACW Wetland Meadow Mix” as produced by Ernst Seeds or approved equal.

1. Item Number: ERNMX-122

2. Seeding Rate: 20 lb per acre, or 1/2 lb per 1,000 sq ft with a cover crop. For a cover crop use one of the following: grain rye (1 Sep to 30 Apr; 30 lbs/acre), Japanese millet (1 May to 31 Aug; 10 lbs/acre), or barnyard grass (1 May to 31 Aug; 10 lbs/acre).

3.4 SEEDED LAWN MIX AND SEEDED NO MOW LAWN MIX

A. Seeded lawn Mix and Seeded No Mow Lawn Mix shall be “Commercial Conservation Mix” as produced by Ernst Seeds or approved equal.

1. Item Number: ERNMX-113

2. 75-150 lb per acre, or 3-5 lb per 1,000 sq ft

2.10 PREPARATION OF PLANTING

A. In preparing plants for moving, all precautions customary in good trade practice shall be taken. Workmanship that fails to meet the highest standards will not be accepted. All plants shall be dug to retain as many fibrous roots as possible. All plants shall be dug immediately before moving to their new locations.

B. Balled and burlapped plants shall have a solid ball of earth of minimum specified size held in place securely by burlap and stout rope. Oversized or exceptionally heavy plants are acceptable if the size of the bark or spread of roots is proportionally increased to the satisfaction of the Landscape Architect. Broken, loose or manufactured balls will be rejected. Ball and platformed plants shall be securely tied with stout rope to sturdy platforms in size to the diameter of the upper half of the ball of earth.

C. Inspection: Plants shall be subject to inspection and approval at place of growth for conformity to specification requirements as to quality, size and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work for size and condition of balls and root systems, diseases, insects and latent defects or injuries. Furnish certificates of inspection of plant materials as may be required for Federal, State or other authorities.

PART 3 – EXECUTION

1. GENERAL

A. General: The top 12” of all plant beds shall be topsoil. The 6” of soil below the topsoil shall be a blend of 50% topsoil and 50% existing or subsoil.

B. Trees: Prior to planting trees, verify and locate top elevation of true root ball and at planting remove excess, alien soil to expose root flare at base of trunk. All trees shall be planted in pits the size of which is shown on the drawings. The depths of the pits shall accommodate the ball of the roots and approved topsoil so that when the tree is settled in the pit, it will not be necessary to raise or lower the tree to bring it to the required grade. Root flare shall be 1 – 2 inches above adjacent grade. When the tree has been properly set, the pit shall be backfilled with topsoil which shall be thoroughly watered during and after the backfilling. No additional topsoil is to be backfilled over root ball.

C. Shrubs: All shrubs shall be planted in the planting beds previously prepared or where free standing in individual pits. Individual shrub pits shall be 18" deep and at least one foot wider than the ball of earth of spread of roots. All pits shall be circular in outline and dug with vertical sides. Mulch as specified and shown.

3.2 PREPARATION

A. Time of planting

1. Following the signing of the contract and prior to the commencement of planting, contact the Landscape Architect to work out a schedule of planting dates to avoid conflicts in the Landscape Architect's planting supervision schedule, as well as the general construction schedule.

2. At the Contractor's option and full responsibility, planting operations may be conducted under unseasonable weather.

3. Planting shall be executed according to the following schedule:

   Unless otherwise directed by the Owner's Representative, deciduous material shall be planted from October 15th to December 15th; evergreen material shall be planted August 15th to October 15th, except balled and burlapped material, which may be planted at such times as the Owner's Representative may direct.

4. Watering: During planting, the soil around each plant shall be thoroughly saturated with water.

5. Maintenance: Maintain all planted areas to the satisfaction of the Owner and the Landscape Architect until final acceptance of the planting. Maintenance shall include watering, cultivating, weeding, spraying, and other horticultural operations necessary for the proper growth of all plants or for keeping the whole area neat in appearance.

3.3 LAYOUT

A. All plants shall be located as shown on drawings except where obstructions overhead or below ground are encountered or where changes have been made in construction. Should obstructions be found, notify the Landscape Architect who will relocate plant material.

3.4 DIGGING

A. Contractor shall comply with "Call Before You Dig" laws requiring utility markouts.

B. All holes for planting shall be dug sufficiently in advance so that plants are out of the ground no longer than necessary. All pits excavated in advance of planting operations shall be adequately protected for the safety of the public.

3.5 BACKFILLING

A. Prior to backfilling, balled and burlapped plants shall have burlap and ropes removed from the trunks, stems and tops of balls. Burlap shall be laid back. No burlap shall be pulled out from under the ball.

B. Backfilling shall be well tamped and watered in twelve inches at a time. To the topsoil used in the backfilling of the tree hole and shrub beds, there shall be added, as the progress of the work permits, manure or peat moss as hereinbefore specified, ground limestone, if soil test indicates it is needed, and commercial fertilizer at the rate of three pounds for trees up to three inches in caliper; one pound per inch caliper for larger trees; six ounces for small shrubs and eight ounces for each shrub four feet or over. Ground limestone and manure shall be omitted in the case of acid soil plants. The manure, limestone and fertilizer shall be incorporated thoroughly with the topsoil in the planting operation, care being taken that the manure does not come into contact with the roots. Unsuitable excavated material from the holes shall not be used in the backfilling of the holes and shall be disposed of off-site as directed by the Owner.

3.6 MULCH

A. Upon completion of planting and prior to application of shredded bark, Commercial Fertilizer Low Phosphorous (Slow Release) shall be incorporated into soil to a depth of three (3") inches at the rate of twenty pounds per thousand square feet (20 lbs./1,000 sf).

B. Shredded bark mulch shall be applied to the surface of the beds as shown on the plans. Mulch shall be applied to a uniform depth as shown on the plans and shall be distributed as to create a smooth level cover over the exposed soil. Plants shall not be covered.

3.7 SEED LAWN

A. Prior to seeding, all areas to receive seed shall be thoroughly loosened with a rototiller to a depth of six (6") inches. All surplus material such as sticks, stones, roots, vegetation, or other objectionable material which might interfere with the formation of a finely pulverized seed bed shall be removed from the soil and a smooth uniform surface grade shall be established. Hollows, depressions, and gullies shall be filled by raking to level and topsoil added as necessary to provide a smooth surface prior to seeding operations. Topsoil shall be spread over the area to receive seed to the depth indicated on the drawings and as required to achieve the designated finished grade. The seed bed shall be graded to true lines, free from all unsightly variations, bumps, ridges, or depressions.

B. Compost, where required, shall be thoroughly incorporated into the top five inches (5") of soil, where seed will be installed on existing topsoil and where soil testing indicates low levels of organic matter. Where required, the compost shall be spread at the rate of one (1) cubic yard per one thousand (1,000) square feet unless otherwise directed. Where seed will be installed on new topsoil, compost shall not be added.

C. Amendments: After the compost has been incorporated into the existing soil, limestone, where required, and fertilizer shall be worked into the top three inches (3") of soil at their respective rate as recommended by the manufacturer.

D. Grass seed shall be sown, covered to the proper depth, and firmed in such a manner that a uniform stand of grass will result. All areas to receive seed shall then be compacted, using a two hundred pound (200 lb.) roller. The seed shall be thoroughly watered immediately after placement. The Contractor shall be liable for any damage to property caused by their sodding operations. All areas and construction disturbed shall be restored to their original condition, to the satisfaction of the Engineer

3.8 SODDING

A. Sod shall be harvested, delivered, and installed within a period of thirty six (36) hours. No sod shall be harvested, delivered, or placed when high temperatures may adversely affect the survival of the Sod.

B. Before any sod is placed, all areas to receive sod shall be thoroughly loosened with a rototiller to a depth of six inches (6"). All sticks, stones, roots, vegetation, or other objectionable material which might interfere with the formation of a finely pulverized sod bed shall be removed from the soil and a smooth uniform surface grade shall be established. Hollows, depressions, and gullies shall be filled by raking to level and topsoil added as necessary to provide a smooth surface prior to sodding. Topsoil shall be spread over the area to receive sod to the depth indicated on the drawings and as required to achieve the designated finished grade.

C. Compost, where required, shall be thoroughly incorporated into the top five inches (5") of soil, where seed will be installed on existing topsoil and where soil testing indicates low levels of organic matter. Where required, the compost shall be spread at the rate of one (1) cubic yard per one thousand (1,000) square feet unless otherwise directed.

D. Amendments: After the compost has been incorporated into the existing soil, limestone, where required, and fertilizer shall be worked into the top three inches (3") of soil at their respective rate as recommended by the manufacturer.

E. The first row of sod shall be laid in a straight line with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered, each piece butted close together with no voids between the pieces. Care shall be exercised to ensure that the sod is not stretched or overlapped. Where mechanical equipment is used to lay sod, flotation tires are to be used. The sod shall be rolled immediately after placement and then thoroughly watered.

F. Sod shall be laid a minimum of four (4) weeks prior to the Final Inspection date to allow the sod to thoroughly knit. All dead sod shall be replaced prior to the Substantial Completion. All extra sod and/or plant debris remaining from the preparation procedure shall be removed from the site. The Contractor shall be liable for any damage to property caused by their sodding operations. All areas and construction disturbed shall be restored to their original condition.

G. Watering of the lawn areas shall be the responsibility of the Contractor until final acceptance.

H. Protection of Sodded Areas: Provide approved protection for sodded areas against trespassing and damage until final acceptance. Should any sod be damaged before final acceptance, repair and replace damaged areas.

3.9 SPECIALTY SEED MIXES

A. Butterfly Meadow Seed Mix, Meadow Seed Mix, Seeded Lawn and Seeded No Mow Lawn:

1. Eradicate existing vegetation by having a licensed spray technician apply an approved herbicide, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other herbicide formulation, to control undesirable vegetation. Contractor shall reference manufacturers recommendations.

2. If the site was previously a lawn or crop field to which herbicides were applied, it is important to allow the appropriate interval for the residues of those herbicides to break down prior to planting. Herbicide residues can prevent seedling germination. Contractor shall reference manufacturers recommendations.

3. Contractor shall reference manufacturers recommended seeding methods for application.

3.10 REPLACEMENT – RESTORATION OF PLANT MATERIAL

A. For the specified period after final acceptance of all planting, at no additional cost to the Owner, replace any plant that is in an unhealthy or unsightly condition, or that has lost its natural shape due to dead branches, excessive pruning, or inadequate or improper maintenance. All replacement planting is to be done no later than the next succeeding planting season after receipt of the Landscape Architect's instructions.

B. Replacement of planting is to be in accordance with the original specifications and its costs considered to be included in the bid price. All areas damaged by tree or shrub replacement shall be repaired at no additional cost to Owner.

C. Vandalism and accidents during the maintenance and guarantee period - Notify the Owner's Representative no later than two weeks after an accident or vandalism has destroyed, killed or rendered unsuitable any of the plants. The Contractor will not be held responsible for the replacement of trees if damaged by vandalism or an accident providing the Owner's Representative is notified in writing within two weeks after the occurrence. If no notification is given the Owner's Representative within two weeks after the occurrence of damage, replace the plants at own cost. Any accidents, damages or vandalism caused by the Contractor shall at all times be the responsibility of the Contractor. Vandalism and accidents occurring before the acceptance of the planting and beginning of the guarantee period, shall be repaired to the satisfaction of the Owner and the Landscape Architect at the Contractor's expense as provided in the specifications.

D. Sum to be retained for maintenance and guarantee - In addition to other sums retained from the final payment in accordance with the Agreement, the sum of 10% of Landscape Bid will be retained by the Owner for a period of one year after final acceptance of the planting as security for the faithful performance by the Contractor of his obligations with respect to the work on the maintenance and guarantee of the horticultural development as described in the specifications. The retained guarantee monies will not be released until the Contractor has satisfied the above requirement.

E. Watering - Water the trees thoroughly as required to maintain healthy plant establishment and growth from time of planting until expiration of the one year guarantee. Should water restrictions be imposed, import suitable water at his own cost and expense.

3.11 MAINTENANCE OF LANDSCAPE WORK

A. Maintenance shall begin immediately after each plant is planted and shall continue until final acceptance of the project. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized and generally maintained to keep them in a healthy, vigorous condition.

3.12 PARTIAL ACCEPTANCE: BEGINNING OF THE GUARANTEE PERIOD

A. Upon completion of all planting operations of well-defined areas and blocks of planted material, to the satisfaction of the Landscape Architect and the Owner, the Contractor may be granted acceptance of such areas for the purpose of beginning of the one year guarantee period. However, this partial acceptance shall not be interpreted, under any circumstances, as a release of all other obligations, responsibilities, and/or liabilities the Contractor may have within the contract limit lines, and until final acceptance of the entire work under this contract. Only one such inspection for partial acceptance will be made at the end of each planting season.

3.13 INSPECTION FOR ACCEPTANCE

A. Inspection of planting work to determine completion of the contract work will be made by the Landscape Architect at the end of the maintenance period, upon notice requesting such an inspection several days prior to the anticipated date.

B. After inspection, the Contractor will be notified in writing by the Landscape Architect of acceptance of the work, or, if there are any deficiencies of the requirements for completion of the

work. Remaining work to be done shall be subject to reinspection before acceptance. Maintenance shall become the responsibility of the Owner immediately upon acceptance.

3.14 GUARANTEE

A. Guarantee all plant material as installed under the contract for a period of one year from date of acceptance. Any material dead, not healthy, dying, or the design value of which in the opinion of the Landscape Architect, has been destroyed through loss of branches, shall be replaced at no cost to the owner. Stakes, wires and hoses shall be removed at the end of the guarantee period. At the time the stakes are removed any holes left by the stake shall be filled with topsoil as specified in the “Topsoil” specification. The removal of the plant material, the fertilizer and topsoil mixture for the replacement and labor shall be at the contractor's expense.

END OF SECTION 32 90 00

SPECIFICATIONS GROUP

Site and Infrastructure Subgroup

DIVISION 33 - UTILITIES

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SECTION 33 41 00

STORM DRAINAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Pipe and Fittings.
   2. Precast Concrete Manholes.
   3. Catch Basins and Drain Inlets.
   4. Head Walls and Pipe Outlets.
   5. Cleanouts.

1.03 DEFINITIONS

A. HDPE: High Density Poly-Ethylene Pipe.

B. RCP: Reinforced Concrete Pipe.

C. DIP: Ductile Iron Pipe.

D. PVC: Polyvinyl chloride plastic.

1.04 GRAVITY-FLOW, NONPRESSURE, DRAINAGE-PIPING PRESSURE RATING: 10-Foot Head of Water. Pipe joints shall be at least silt-tight, unless otherwise indicated.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
   1. Manholes: Include plans, elevations, sections, details, frames, and covers. Include design calculations, and concrete design-mix report for cast-in-place manholes.
   2. Catch Basins and Drain Inlets: Include plans, elevations, sections, details, frames, covers, and grates. Include design calculations, and concrete design-mix report for cast-in-place catch basins and drain inlets.
   3. Head Walls: Includes plans, elevations, sections, details and design calculations. Include design calculations, and concrete design-mix report for cast-in-place wing walls.

C. Field quality-control reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle manholes, catch basins, and other precast concrete drainage structures according to manufacturer's written rigging instructions.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than two weeks in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE PIPE

A. All high density polyethylene pipe, with smooth inner liner:
   1. Corrugated polyethylene drainage tubing (3” to 10”), AASHTO M 252-94.
   2. Corrugated polyethylene pipe (12” to 30”), AASHTO M 294-94.
   3. Corrugated polyethylene pipe (30” to 60”), ASTM D2321, AASHTO M 294.

B. Pipe shall be joined with a watertight gasketed integral bell and spigot joint, ASTM D3212, ASTM F477.

2.02 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Pipe and Fittings: Shall be Class IV pipe meeting ASTM C 76, with bell-and-spigot ends and sealant joints with ASTM C 990, bitumen or butyl-rubber sealant.

2.03 DUCTILE-IRON PIPE AND FITTINGS

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile.
2. Gaskets: AWWA C111, rubber.

2.04 PVC PIPE AND FITTINGS

A. PVC Pressure Pipe: AWWA C900, Class 150, for gasketed joints and using ASTM F 477, elastomeric seals.
   1. Fittings NPS 4 to NPS 8: PVC pressure fittings complying with AWWA C907, for gasketed joints and using ASTM F 477, elastomeric seals.

2. Fittings NPS 10 and Larger: Ductile-iron, compact fittings complying with AWWA C153, for push-on joints and using AWWA C111, rubber gaskets.

B. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.05 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For CMP: As recommended by manufacturer for intended use.
2. For Concrete Pipes: ASTM C 443, rubber.
3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.06 MANHOLES

A. Precast Concrete Manholes: Provide as detailed on plans and all assemblies shall provide for H-20 Loading.
1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum up to 10 feet and 60 inches excess of 10 feet unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 5-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: Plastic coated steel steps cast into sidewalls at 12-inch intervals.
10. Adjusting Rings: Interlocking precast concrete rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

B. Manhole Frames and Covers:
1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM DRAIN."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.07 CATCH BASINS AND DRAIN INLETS

A. Precast Concrete Catch Basins and Drain Inlets: Provide as detailed on plans and all assemblies shall provide for H-20 Loading.
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   3. Riser Sections: 5-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
   4. Top Section: Flat-slab-top type is indicated.
   5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
   6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
   7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

2.08 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/ cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 1 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: In accordance with plan invert elevations.

D. Ballast and Pipe Supports: Portland cement design mix, 4000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.09 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   1. Top-Loading Classification(s): Heavy duty.
   2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping. All PVC cleanouts shall have flush tops.

2.10 HEAD WALLS AND PIPE OUTLETS

A. Head Walls: Precast or Cast-in-place reinforced concrete, with apron and tapered sides as detailed on the plans.

B. End Sections: Shall be Class IV reinforced concrete pipe meeting ASTM C 76.

C. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated on the plans.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section 312000 Earthwork.

3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.

2. Install piping with 24-inch minimum cover, unless noted otherwise on the plans.
3. Install ductile-iron culvert piping according to ASTM A 716.
4. Install corrugated metal piping according to ASTM A 798/A 798M.
5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.03 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.04 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3-inches above finished surface elsewhere unless otherwise indicated.

3.05 CATCH BASIN AND DRAIN INLET INSTALLATION

A. Construct catch basins to sizes and shapes indicated on plans.

B. Set frames and grates to elevations indicated on plans.

3.06 PIPE OUTLETS

A. Construct head walls, wing walls and aprons of reinforced concrete, as indicated on the plans.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

D. Construct energy dissipaters at outlets, as indicated on plans.

3.07 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.08 IDENTIFICATION

A. Pipe backfill and bedding materials and their installation are specified in Division 31 Section 312000 Earthwork. Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
   1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.09 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Excavate and remove existing pipe and legally dispose offsite.

B. Abandoned Manholes and Structures: Excavate around manholes and remove and legally dispose off site.

C. Backfill to grade according to Division 31 Section 312000 Earthwork.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24-inches of backfill is in place, and again at completion of Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Leaks and loss in test pressure constitute defects that must be repaired.

C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 33 41 00

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SECTION 33 46 00

SUBDRAINAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Westchester County Health Care Corporation General Conditions and any Supplementary Conditions and applicable portions of Division 1 – General Requirements of the Specifications apply to this Section.

1.02 SUMMARY

A. This Section includes subdrainage systems for the following:
   1. Retaining walls.
   2. Underdrains.
   3. Drainage swales.

1.03 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Perforated-wall pipe and fittings.
   2. Solid-wall pipe and fittings.
   3. Drainage conduits.
   4. Crushed stone.
   5. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.01 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.02 SOLID-WALL PIPES AND FITTINGS

A. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
   1. Gaskets: ASTM F 477, elastomeric seal.

2.03 CLEANOUTS

A. PVC Cleanouts: ASTM D 3034, PVC cleanout flush threaded plug and threaded pipe hub.

2.04 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.
   1. Manufacturers:
      a. American Wick Drain Corporation.
      b. JDR Enterprises, Inc.
      c. TC Mirafi.
   2. Nominal Size: 12 inches high by approximately 1 inch thick.
      a. Minimum In-Plane Flow: 30 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   3. Nominal Size: 18 inches high by approximately 1 inch thick.
      a. Minimum In-Plane Flow: 45 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   4. Filter Fabric: PP geotextile.
   5. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
   1. Manufacturers:
      a. Varicore Technologies, Inc.
   2. Nominal Size: 6 inches high by approximately 1-1/4 inches thick.
      a. Minimum In-Plane Flow: 15 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   3. Nominal Size: 12 inches high by approximately 1-1/4 inches thick.
      a. Minimum In-Plane Flow: 30 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   4. Nominal Size: 18 inches high by approximately 1-1/4 inches thick.
      a. Minimum In-Plane Flow: 45 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   5. Filter Fabric: Nonwoven, needle-punched geotextile.
   6. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
   7. Couplings: HDPE.

C. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
   1. Manufacturers:
      a. Colbond Geosynthetics.
   2. Nominal Size: 6 inches high by approximately 0.9 inch thick.
      a. Minimum In-Plane Flow: 2.4 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   3. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. when tested according to ASTM D 4491.

2.05 SOIL MATERIALS

A. Backfill, bedding and drainage courses, and soil materials are specified in Division 31, Section 312000 "Earthwork."

2.06 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
   1. Structure Type: woven, monofilament or multifilament.
   2. Style(s): Flat.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31, Section 312000 "Earthwork."

3.03 PIPING APPLICATIONS

A. Underground Subdrainage Piping:
   1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Underslab Subdrainage Piping:
   1. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.

C. Header Piping:
   1. PVC sewer pipe and fittings, couplings, and coupled joints.

3.04 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:
   1. At Grade in Earth: Cast-iron cleanouts.
   2. At Grade in Paved Areas: Cast-iron cleanouts.

3.05 FOUNDATION DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of bedding course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 6 inches.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

E. Add bedding course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

F. Cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

G. Install bedding course and wrap top of bedding course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric roofing felt over top of bedding course, overlapping edges at least 4 inches.

I. Install vertical drainage panels as follows:
   1. Coordinate placement with other drainage materials.
   2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article. Do not install aggregate.
   3. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
   4. Wrap bottom of panel around drainage pipe.
   5. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
   6. If additional panels are required on same row, cut away 4 inches of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
   7. If additional rows of panels are required, overlap lower panel with 4 inches of fabric.
   8. Cut panel as necessary to keep top 12 inches below finish grade.
   9. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.

J. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.

K. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.06 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 6 inches.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping in accordance with manufacturer’s recommendations.

F. Add bedding course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

H. Install horizontal drainage panels as follows:
1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footings.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.07 RETAINING-WALL DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of bedding course over compacted subgrade to compacted depth of not less than 6 inches.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

D. Install drainage piping in accordance with manufacturer's specifications.

E. Add bedding course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

G. Place bedding course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of bedding course, overlapping edges at least 4 inches.

I. Install vertical drainage panels as follows:
1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
3. If weep holes are used instead of drainage pipe, cut 1/2-inch diameter holes on core side at weep-hole locations. Do not cut fabric.
4. Mark horizontal chalk line on wall at a point 6 inches less than panel width above footing bottom. Before marking wall, subtract footing width.
5. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
6. Wrap bottom of panel around drainage pipe.
7. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.

8. If another panel is required on same row, cut away 4 inches of installed panel core and wrap fabric over new panel.
9. If additional rows of panel are required, overlap lower panel with 4 inches of fabric.
10. Cut panel as necessary to keep top 12 inches below finish grade.
11. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
12. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.

J. Fill to Grade: Place satisfactory soil fill material over compacted bedding course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.08 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of bedding course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 6 inches.

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.

G. Install bedding course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

I. Fill to Grade: Place satisfactory soil fill material over bedding course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.09 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
3. Deck Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 1.0 percent.
4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of

0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.

5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
6. Lay perforated pipe with perforations down.
7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D 2321.

3.10 PIPE JOINT CONSTRUCTION

A. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

B. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.11 CLEANOUT INSTALLATION

A. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:
1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in non-vehicular traffic areas.
3. In non-vehicular traffic areas, use NPS 4 cast-iron pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.

B. Cleanouts for Underslab Subdrainage:
1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.12 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to building's site storm drainage system, after sand filters and detention basins.

3.13 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section 312000 "Earthwork." Arrange for installation of green warning tapes directly over piping.
   1. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.14 FIELD QUALITY CONTROL

A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.15 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 46 00