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Project Manual

Bid Documents

SUCF PROJECT NO. 041046-00

PROJECT TITLE: Renovate Corey Union

DATE: November 16, 2026

SUNY CORTLAND

State University Construction Fund
State University Plaza
353 Broadway
Albany, New York 12246

"TO THE BEST OF MY KNOWLEDGE, INFORMATION, AND BELIEF, THE CONSTRUCTION DOCUMENTS FOR THIS PROJECT ARE IN CONFORMANCE WITH THE BUILDING CODE OF NEW YORK STATE AND ALL OTHER APPLICABLE FEDERAL AND STATE LAWS AND REGULATIONS, ALL AS CURRENTLY AMENDED"

Steven D. Fernaays	031855	12/15/2025
Name of Registered Professional	NYS Registration No.	Date

ARCHITECT, INTERIOR DESIGNER, LANDSCAPE ARCHITECT, AND STRUCTURAL ENGINEER: SWBR 260 East Main Street, Suite 4000 Rochester, NY 14604 Phone: (585) 232-8300	MECHANICAL, PLUMBING AND FIRE PROTECTION ENGINEERS: Popli Design Group 45 Lewis Street Binghamton, NY 13901 Phone: (607) 238-5888	ELECTRICAL ENGINEER: Jade Stone Engineering 444 Vanduzee Street Watertown, NY 13601 Phone: (315) 836-4062
HAZARDOUS MATERIAL ABATEMENT DESIGNER: C&S Companies 499 Col. Eileen Collins Boulevard Syracuse, NY 13212 Phone: (315) 455-2000	FOOD SERVICE DESIGNER: Culinary Advisors 3734 Crow Bow Court Ellicott City, MD 21042 Phone: (410) 750-9467	COMMUNICATIONS, DATA, AND SECURITY DESIGNER: Bright Tree Studios 301 Brush Creek Road Warrendale, PA 15086 Phone: (412) 212-7515
GEOTHERMAL ENGINEER: Salas O'Brien Consulting and Engineering Group of NY, Inc 300 Trolley Boulevard Rochester, NY 14606 Phone: (585) 288-5590	ACOUSTICAL CONSULTANT: Ostergaard Acoustical Associates 1460 US Highway 9 North, Suite 209 Woodbridge, NY 07095 Phone: (973) 731-7002	CIVIL ENGINEERS: Popli Design Group 45 Lewis Street Binghamton, NY 13901 Phone: (607) 238-5888

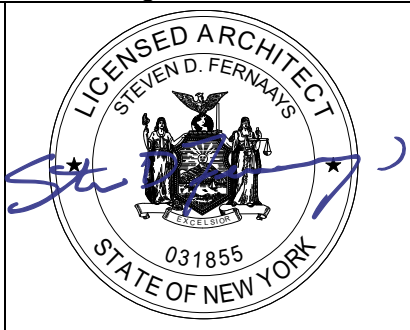
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1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect, Interior Designer, Landscape Architect, and Structural Engineer:

SWBR 260 East Main Street, Suite 4000 Rochester, NY 14604 Phone: (585) 232-8300	 Issue Date: 11/16/26 Registration Expires: 11/30/27

B. Mechanical, Plumbing and Fire Protection Engineer:

Popli Design Group 220 Alexander Street, Suite 700 Rochester, NY 14607-4002 Phone: (585) 388-2060	

C. Electrical Engineer:

Jade Stone Engineering 444 Vanduzee Street Watertown, NY 13601 Phone: (315) 836-4062	

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D. Hazardous Material Abatement Designer:

C&S Companies 499 Col. Eileen Collins Boulevard Syracuse, NY 13212 Phone: (315) 455-2000	

Reg. Exp: 04/30/2029
Cert. of Auth: 086008

E. Geothermal Engineer:

Salas O'Brien Consulting and Engineering Group of New York, Inc. 300 Trolley Boulevard Rochester, NY 14606 Phone: (585) 288-5590	

Reg. Exp: 09/30/2028
Cert. of Auth: 0018443

A. Civil Engineer:

Popli Design Group 170 Franklin Street, 8th Floor Buffalo, NY 14202 Phone: (716) 625-9200	

Reg. Exp: 09/30/2027
Cert. of Auth: 3310946

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(Refer to Section 2.12 of the Agreement regarding use of this information)

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1.1 SUMMARY

A. Section Includes:
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   2. Sleeves with waterstop.
   3. Sleeve-seal systems.
   4. Grout.
   5. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

2.2 SLEEVES WITH WATERSTOP

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
2. CALPICO, Inc.
3. GPT; a division of EnPRO Industries.
4. Metraflex Company (The).

B. Description: Manufactured PVC/HDPE, steel, stainless steel, galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
2. CALPICO, Inc.
3. GPT; a division of EnPRO Industries.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Designed to form a hydrostatic seal of 20 psig minimum.

2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
3. Pressure Plates: Carbon steel or Composite plastic.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. GE Construction Sealants; Momentive Performance Materials Inc.
b. Permathane; a Holcim brand.
c. Polymeric Systems, Inc.
d. Sherwin-Williams Company (The).
e. Sika Corporation.
f. The Dow Chemical Company.
g. Tremco Incorporated.
2. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

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 or silicone sealant, seal 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.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs 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 or silicone sealant, seal space around outside of sleeves.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

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

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 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
   2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above and below Grade:
      a. Sleeves with waterstops.
         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. Sleeves with waterstops.
         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. Sleeves with waterstops.
   4. Interior Walls and Partitions:
      a. Sleeves without waterstops.

END OF SECTION 21 05 17

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. BrassCraft Manufacturing Co.; a Masco company.
   2. Dearborn Brass.
   3. Jones Stephens Corp.
   4. Keeney Manufacturing Company (The).
   5. Mid-America Fittings, LLC; A Midland Industries Company.

2.2 ESCUTCHEONS

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

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

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

D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with 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.
   b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
   c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
   d. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
   f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
   h. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

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

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

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 21 05 18

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SECTION 21 05 23 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Iron butterfly valves with indicators.
   2. Check valves.
   3. Iron OS&Y gate valves.
   4. NRS gate valves.
   5. Indicator posts.
   6. Trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
   1. Fire Main Equipment: HAMV - Main Level.
      a. Indicator Posts, Gate Valve.
      b. Ball Valves, System Control.
      c. Butterfly Valves.
      d. Check Valves.
      e. Gate Valves.
   2. Sprinkler System and Water Spray System Devices.
      a. 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
         3) Miscellaneous valves.

C. ASME Compliance:

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

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

E. NFPA Compliance for valves:
1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

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

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

H. 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.

2.3 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ALEUM USA.
2. Anvil; an ASC Engineered Solution.
3. Globe Fire Sprinkler Corporation.
4. Kennedy Valve Company; a division of McWane, Inc.
5. NIBCO INC.
6. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
7. Victaulic Company.
8. Zurn Industries, LLC.

B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer.

2.4 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ames Fire & Waterworks; A Watts Water Technologies Company.
   2. FEBCO; A WATTS Brand.
   3. Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
   4. Globe Fire Sprinkler Corporation.
   5. Kennedy Valve Company; a division of McWane, Inc.
   6. Matco-Norca.
   7. Mueller Co. LLC; Mueller Water Products, Inc.
   8. NIBCO INC.
   9. Reliable Automatic Sprinkler Co., Inc. (The).

B. Description:
   1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
   2. Minimum Pressure Rating: 175 psig.
   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.

2.5 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Cast Iron Pipe Company.
   2. Clow Valve Company; a subsidiary of McWane, Inc.
   3. Hammond Valve.
   4. Kennedy Valve Company; a division of McWane, Inc.
   5. Mueller Co. LLC; Mueller Water Products, Inc.
   6. NIBCO INC.
   7. Victaulic Company.
   8. WATTS; A Watts Water Technologies Company.
   9. Zurn Industries, LLC.
   10. FNW; Ferguson Enterprises, Inc.

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 with elastomeric coating.

5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.6 NRS GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Cast Iron Pipe Company.
2. Mueller Co. LLC; Mueller Water Products, Inc.
3. NIBCO INC.
4. Victaulic Company.
5. Zurn Industries, LLC.
6. Kennedy Valve Company; a division of McWane, Inc.

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

2.7 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Croker; a Division of Morris Group International.
c. Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
d. Jomar Valve.
e. KITZ Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Potter Roemer LLC; a Division of Morris Group International.
i. Red-White Valve Corp.

2. Description:
a. Pressure Rating: 175 psig.

b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
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.

C. Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. United Brass Works, Inc.
c. Milwaukee Valve Company
d. Apollo Valves
2. Description:
a. Pressure Rating: 175 psig.
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
   1. Section 211200 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
   2. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-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 double-check valve assembly in each fire-protection water-supply connection.

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.

END OF SECTION 21 05 23

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

PART 1 - GENERAL

1.1 SUMMARY

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

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details.

C. Delegated Design Submittal: For hangers and supports for fire-suppression piping and equipment, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design for Structural Performance: Engage a qualified professional engineer to design hangers and supports for fire-suppression piping and equipment. The professional engineer must confirm that the capacity of the existing structure is adequate where it will be used to support piping and equipment. Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions according to the Building Code of New York State.
   1. Design supports for multiple pipes, including pipe stand and trapeze hangers, 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. Professional Engineering Qualifications: A professional engineer who is legally qualified to practice in New York State and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of systems or assemblies that are similar to those indicated for this Project in material, design, and extent.

B. NFPA Compliance: Comply with NFPA 13.

C. UL Compliance: Comply with UL 203.

D. All hangers and supports shall be in conformance with ANSI MSS SP-58, latest edition.

2.2 METAL PIPE HANGERS AND SUPPORTS

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

B. Stainless-Steel Pipe Hangers and Supports: (Corrosive Areas)
1. Description: MSS SP-58, Type 304, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of Type 304 stainless steel.

C. Copper Pipe and Tube Hangers:
1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

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

B. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from type 304 stainless steel-steel shapes, with NFPA-approved, UL-listed, or FM-approved stainless-steel hanger rods, nuts, saddles, and U-bolts in corrosive areas.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Buckaroos, Inc.
2. Carpenter & Paterson, Inc.
3. KB Enterprise.
4. National Pipe Hanger Corporation.
5. Pipe Shields Inc.
6. Piping Technology & Products, Inc.
7. Rilco Manufacturing Co., Inc.
8. Value Engineered Products, Inc.

B. Insulation-Insert Material: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi 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 beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-Line; a division of Eaton, Electrical Sector.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      e. MKT Fastening, LLC.
   2. Indoor Applications: Zinc-coated or Stainless steel (corrosive areas).
   3. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

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

2.7 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
   3. Field fabricate from ASTM A36/A36M type 304 stainless-steel shapes selected for loads being supported in corrosive areas. Weld steel according to AWS D1.1/D1.1M.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
   2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

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

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

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

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

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

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

3.3 EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.5 ADJUSTING

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

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

3.6 PAINTING

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099000 "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

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

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings, unless located in a corrosive area as designated on the Contract Drawings, for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for corrosive areas as indicated on the Contract Drawings.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
   3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

PIPE HANGER SUPPORT SCHEDULE			
PIPE SIZE	MAXIMUM HORIZONTAL HANGER SPACING (FEET)		
	COPPER PIPE (FT.)	STEEL PIPE (FT.)	MINIMUM ROD SIZE (INCHES)
1/2	5	6	3/8
3/4	5	6	3/8
1	6	6	3/8
1 1/4	6	6	3/8
1 1/2	6	6	3/8
2	7	7	3/8
2 1/2	8	10	1/2
3	10	10	1/2
4	10	10	5/8
6	10	10	3/4

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

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

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.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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.
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.

END OF SECTION 21 05 29

IDENTIFICATION FOR FIRE-SUPRESSION PIPING AND EQUIPMENT

SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Carlton Industries, LP.
c. Champion America.
d. Craftmark Pipe Markers.
e. Marking Services Inc.
f. Pipemarker.com; Brimar Industries, Inc.
g. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Brass, 0.032 inch thick, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

IDENTIFICATION FOR FIRE-SUPRESSION PIPING AND EQUIPMENT

B. Plastic Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. Champion America.
      d. Craftmark Pipe Markers.
      e. Kolbi Pipe Marker Co.
      f. LEM Products Inc.
      g. Marking Services Inc.
      h. Pipemarker.com; Brimar Industries, Inc.
      i. Seton Identification Products; a Brady Corporation company.
      j. emedco.
   2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch] thick, with predrilled holes for attachment hardware.
   3. Letter and Background Color: As indicated for specific application under Part 3.
   4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless steel rivets or self-tapping screws.

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

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

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. Marking Services Inc.
6. National Marker Company.
7. Pipemarker.com; Brimar Industries, Inc.
8. Seton Identification Products; a Brady Corporation company.
9. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

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

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

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

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

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

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

IDENTIFICATION FOR FIRE-SUPRESSION PIPING AND EQUIPMENT

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

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. Kolbi Pipe Marker Co.
6. LEM Products Inc.
7. Marking Services Inc.
8. Pipemarker.com; Brimar Industries, Inc.
9. Seton Identification Products; a Brady Corporation company.
10. emedco.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

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

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

F. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 PREPARATION

IDENTIFICATION FOR FIRE-SUPRESSION PIPING AND EQUIPMENT

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.

3.2 INSTALLATION GENERAL 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 identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of fire-suppression equipment.

B. Sign and Label Colors:
1. White letters on an ANSI Z535.1 safety-red background.

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Pipe markers: Identify all pipe with durable vinyl plastic adhesive backed lettered labels. Pipe markers shall conform to the requirements of the “Scheme for Identification of Piping systems ASME A13.1 (latest edition) and letter sizes shall be in accordance with the USASI Standard. Straight lines of pipe shall be identified at intervals of 20 feet, and at least once in each room. Piping shall be identified at points near all turns, valves, at the upstream side of the fittings or branches, and at each side of wall crossings. Apply black arrows adjacent identification labels to indicate direction of flow.

B. Valve Tags: Durable, rigid plastic, or stainless steel tags. All tags shall be a neat uniform design, with lettering embossed in metal or engraved plastic. Tags shall clearly identify the number of the valve.

IDENTIFICATION FOR FIRE-SUPRESSION PIPING AND EQUIPMENT

C. Proposed pipe Marker Color Schedule Matrix. Contractor shall select a marker supplier with available colors as close as possible to match the following list:
   1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background.

END OF SECTION 21 05 53

SECTION 21 12 00 - 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 gauges.

B. Related Requirements:
1. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping."
2. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.

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.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, drawn to scale, or BIM model, showing the items described in this Section and coordinated with all building trades.

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

C. Welding certificates.

D. Fire-hydrant flow test report.

E. 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."

F. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

A. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections and has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

2.2 PERFORMANCE REQUIREMENTS

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

B. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.

C. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psigminimum working pressure.

D. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
   1. Minimum and maximum residual pressure at each hose-connection outlet is as follows:
      a. NPS 2-1/2 Hose Connections: 65 psig.
      b. NPS 2-1/2 Hose Connections: 175 psig

E. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service in accordance with requirements indicated:
   1. Notify Construction Manager and owner no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
   2. Do not proceed with interruption of fire-suppression standpipe service without Construction Manager's and Owner’s written permission.

2.3 PIPING MATERIALS

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

2.4 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A53/A53M, Type E, Grade B, with factory- or field-formed ends to accommodate joining method.

B. Uncoated, Steel Couplings: ASTM A865/A865M, threaded.

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

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

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

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

G. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

H. Grooved-Joint, Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. CPS Products, Inc.
   c. National Fittings, Inc.
   d. Shurjoint; a part of Aalberts Integrated Piping Systems.
   e. Smith-Cooper International.
   f. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   g. Victaulic Company.
2. Pressure Rating: 175-psig minimum.
3. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A47/A47M malleable-iron casting or ASTM A536 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.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.
1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.

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

2.6 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating:
a. Standard-Pressure Piping Specialty Valves: 175-psigminimum.
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, provide products by one of the following:
a. Globe Fire Sprinkler Corporation.
b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
c. Victaulic Company.
d. Viking Group Inc.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber and fill-line attachment with strainer.
5. 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, provide products by one of the following:

a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
c. United Brass Works
2. Standard: UL 1726.
3. Pressure Rating: 175-psigminimum.
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, provide products by one of the following:
   a. Brooks Equipment Co., Inc.
   b. Elkhart Brass Mfg. Co., Inc.
   c. Potter Roemer LLC; a Division of Morris Group International.
   d. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   e. Zurn Industries, LLC.
2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300-psigminimum.
4. Material: Brass or bronze.
5. Size: NPS 2-1/2as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle
9. Finish: Rough brass or bronze

2.8 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

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

C. Pressure Switches (Integral to zone control valve assembly):
   1. Standard: UL 346.
   2. Type: Electrically supervised water-flow switch with retard feature.
   3. Components: Single-pole, double-throw switch with normally closed contacts.
   4. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches (Integral to zone control valve assembly):
   1. Standard: UL 346.
   2. Type: Electrically supervised.
   3. Components: Single-pole, double-throw switch with normally closed contacts.
   4. Design: Signals that controlled valve is in other than fully open position.

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 the building's existing fire protection distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

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

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

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

F. Install alarm devices in piping systems.

G. Install hangers and supports for standpipe system piping in accordance with NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

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

I. Fill wet-type standpipe system piping with water.

J. 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."

K. 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."

L. 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 2and 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 in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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 in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

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

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with NFPA 14, authorities having jurisdiction and manufacturer's instructions.

B. Install listed fire-protection supervised-open shutoff valves, 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 2-1/2hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2reducer adapter and flow-restricting device.

3.7 HOSE-STATION INSTALLATION

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

B. Install NPS 2-1/2hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device unless otherwise indicated.

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

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping in accordance with NFPA 14 requirements.

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

3.9 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 in accordance with 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. 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.

3.10 DEMONSTRATION

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

3.11 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Standard-pressure, 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 cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded 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.
   3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

END OF SECTION 21 12 00

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Steel pipe and fittings.
2. Cover system for sprinkler piping.
3. Air vent.
4. Sprinkler piping specialties.
5. Specialty valves.
6. Sprinklers.
7. Manual control stations.
8. Pressure gauges.

B. Related Requirements:
1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.

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. Design Submittals: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data, prepared by a qualified professional engineer and NICET Level III-certified technician, "Water-Based Systems Layout." Engineering and NICET certified-technician submittals are to include the following information on each drawing title block: Name of professional engineer and NYS professional Engineering seal, technician's name, NICET certification number, and, NICET certification specialty area and level.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Qualification Data: For qualified Installer and professional engineer.

C. Design Data: Approved sprinkler piping working plans, prepared according to NFPA 13, including documented approval by authorities having jurisdiction, and including hydraulic calculations.

D. Field Test Reports: 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."

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 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 and NICET Level III-certified technician, "Water-Based Systems Layout."

PART 2 - PRODUCTS

2.1 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. Sprinkler system equipment, specialties, accessories, installation, and testing to comply with NFPA 13.

C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
1. Available fire-hydrant flow test records indicate the following conditions and are noted on drawing F002:
2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:
a. All Floors – Light Hazard
b. Basement Mechanical Boiler Room, 4th floor mechanical rooms – Ordinary Hazard 1

4. Minimum Density for Automatic-Sprinkler Piping Design:
a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500 sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1500 sq. ft. area.
5. Maximum protection area per sprinkler according to UL listing.
6. Maximum Protection Area per Sprinkler:

a. Light Hazard – 225sq. ft
b. Ordinary Hazard 1 – 130sq. ft

2.2 STEEL PIPE AND FITTINGS

A. Steel or galvanized steel pipe, Schedule 40 minimum, ASTM A53/A53M, Type E or S, Grade A, or ASTM A106. Pipe ends may be factory or field formed to match joining method.

B. Steel Couplings: Galvanized steel, ASTM A865/A865M, threaded.

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

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

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

F. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or.
   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.

G. Grooved-Joint, Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. CPS Products, Inc.
   c. Shurjoint; a part of Aalberts Integrated Piping Systems.
   d. Smith-Cooper International.
   e. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   f. Victaulic Company.
2. Pressure Rating: 175-psig minimum.
3. Grooved-End Fittings for Steel Piping: Galvanized grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, 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.

H. 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.

2.3 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. Automatic (Ball Drip) Drain Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co., Inc. (The).
      b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
      c. AGF Manufacturing
   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.

2.4 AIR VENT

A. Manual Air Vent/Valve:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AGF Manufacturing, Inc.
      b. National Fittings, Inc.
      c. Shurjoint; a part of Aalberts Integrated Piping Systems.
      d. Victaulic Company.
   2. Description: Ball valve that requires human intervention to vent air.
   3. Body: Forged brass.
   4. Ends: Threaded.
   5. Minimize Size: 1/2 inch.
   6. Minimum Water Working Pressure Rating: 300 psig.

B. Automatic Air Vent:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AGF Manufacturing, Inc.
      b. CLA-VAL.
      c. Engineered Corrosion Solutions.
      d. Metraflex Company (The).
      e. Reliable Automatic Sprinkler Co., Inc. (The).
      f. Val-Matic Valve & Manufacturing Corp.

2. Description: Automatic air vent that automatically vents trapped air without human intervention.
3. Standard: UL listed or FM Global approved for wet-pipe fire sprinkler systems.
4. Vents oxygen continuously from system.
5. Float valve to prevent water discharge.
6. Minimum Water Working Pressure Rating: 175 psig.

C. Automatic Air Vent Assembly:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing, Inc.
   b. Engineered Corrosion Solutions.
   c. Potter Electric Signal Company, LLC.
   d. South-Tek Systems, LLC.
2. Description: Automaticair vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a prepiped assembly.
3. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
4. Vents oxygen continuously from system.
5. Float valve to prevent water discharge.
6. Minimum Water Working Pressure Rating: 175 psig.

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. National Fittings, Inc.
   c. Shurjoint; a part of Aalberts Integrated Piping Systems.
   d. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   e. Victaulic Company.
   f. AGF Manufacturing, Inc.
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, provide products by one of the following:

a. AGF Manufacturing, Inc.
b. Reliable Automatic Sprinkler Co., Inc. (The).
c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
d. 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, provide products by one of the following:
a. AGF Manufacturing, Inc.
b. Croker; a Division of Morris Group International.
c. Elkhart Brass Mfg. Co., Inc.
d. Potter Electric Signal Company, LLC.
e. Potter Roemer LLC; a Division of Morris Group International.
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, provide products by one of the following:
a. AGF Manufacturing, Inc.
b. Triple R Specialty.
c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
d. Victaulic Company.
e. Viking Group Inc.
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, provide products by one of the following:
   a. Aegis Technologies, Inc.
   b. CECA, LLC.
   c. CPS Products, Inc.
   d. 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.

F. Flexible Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ALEUM USA.
   b. Flexhead; an ASC Engineered Solution.
   c. Gateway Tubing, Inc.
   d. Reliable Automatic Sprinkler Co., Inc. (The).
   e. Victaulic Company.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.6 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
4. Victaulic Company.
5. Viking Group Inc.

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. Characteristics: Refer to Sprinkler Schedule on Drawing F001 for requirements.

F. Sprinkler Finishes: bronze.

G. 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.

H. Sprinkler Guards:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co., Inc. (The).
      b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
      c. Victaulic Company.
      d. Viking Group Inc.
   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 GAUGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AGF Manufacturing, Inc.
   2. AMETEK, Inc.
   3. Ashcroft Inc.
   4. Brecco Corporation.
   5. WIKA Instrument Corporation.

B. Standard: UL 393.

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

D. Pressure Gauge 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 existing interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

3.2 INSTALLATION OF PIPING

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

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

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

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

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

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

I. Fill sprinkler system piping with water.

J. 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."

K. 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."

L. 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. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, 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.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. 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.

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

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

3.4 INSTALLATION OF VALVES AND SPECIALTIES

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. Specialty Valves:
   1. Install valves in vertical position for proper direction of flow, in main supply to system.

D. Air Vent:
   1. Provide at least one air vent in each wet pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
   2. Provide dielectric union for dissimilar metals, ball or globe valve, and strainer upstream of automatic air vent.
   3. Pipe from outlet of air vent to drain.

3.5 INSTALLATION OF SPRINKLERS

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. 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.

3.8 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, Wet-Pipe Sprinkler System, NPS 3 (DN 50) and Smaller, to Be the Following:
1. Steel or galvanized steel pipe, Schedule 40 minimum, ASTM A53/A53M, Type E or S, Grade A, or ASTM A106.

D. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 4 to NPS 8 (DN 65 to DN 100), to Be the Following:
1. Steel or galvanized steel pipe, Schedule 40 minimum, ASTM A53/A53M, Type E or S, Grade A, or ASTM A106.

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: Pendent sprinklers.
3. Wall Mounting: Sidewall 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 21 13 13

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg F and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:
1. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
1. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packless expansion joints.
   2. Alignment guides and anchors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 PACKLESS EXPANSION JOINTS

A. Rubber Union Connector Expansion Joints: RUEJ-01.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amber/Booth Company, Inc.; a VMC Group Company.
      b. Flex-Hose Co., Inc.
      c. Flexicraft Industries.
      d. Flo Fab Inc.
      e. Mason Industries, Inc.
      f. Metraflex Company (The).
   2. Material: Twin reinforced-rubber spheres.
   3. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.
   4. End Connections for NPS 2 and Smaller: Threaded.

B. Flexible-Hose Packless Expansion Joints: FHEJ-01.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ASC Engineered Solutions.
      b. Flex-Hose Co., Inc.
      c. Flex-Pression.
      d. Flexicraft Industries.
      e. Mason Industries, Inc.
      f. Metraflex Company (The).
   2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
   3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
   a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
   a. Stainless steel hoses and single-braid, stainless steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon steel fittings with threaded end connections.
   a. Stainless steel hoses and single-braid, stainless steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon steel fittings with flanged end connections.
   a. Stainless steel hoses and single-braid, stainless steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
   b. Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
   c. Stainless steel hoses and single-braid, stainless steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

C. Externally Pressurized Metal-Bellows Packless Expansion Joints: EPEJ-01.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing LLC.
   b. Flex-Hose Co., Inc.
   c. Flexicraft Industries.
   d. Mason Industries, Inc.
   e. Metraflex Company (The).
2. Minimum Pressure Rating: 150 psig unless otherwise indicated.
3. Description:
   a. Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
   b. Carbon steel housing.
   c. Drain plugs and lifting lug for NPS 3 and larger.

d. Bellows: With operating clearance between the internal pipe sleeves and external shrouds.
e. Joints: Supplied with a built-in scale to confirm the starting position and operating movement.
f. Joint Axial Movement: 4 inches of compression and 0.75 inch of extension.

4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides: AG-01.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ASC Engineered Solutions.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.
d. Flexicraft Industries.
e. Mason Industries, Inc.
f. Metraflex Company (The).
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:
1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
a. Stud: Threaded, zinc-coated carbon steel.
b. Expansion Plug: Zinc-coated carbon steel.
c. Washer and Nut: Zinc-coated carbon steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
c. Washer and Nut: Zinc-coated carbon steel.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

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

3.2 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

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

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

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

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

E. Anchor Attachments:
1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.3 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

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

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

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

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

END OF SECTION 22 05 16

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Sleeve-seal systems.
4. Grout.
5. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

2.2 SLEEVES WITH WATERSTOP

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
2. CALPICO, Inc.
3. GPT; a division of EnPRO Industries.
4. Metraflex Company (The).

B. Description: Manufactured steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Description: Manufactured, galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, LLC.
   2. CALPICO, Inc.
   3. GPT; a division of EnPRO Industries.
   4. Metraflex Company (The).
   5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Designed to form a hydrostatic seal of 20 psig minimum.
   2. Sealing Elements: EPDM-rubber 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.
   4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Permathane; a Holcim brand.
      c. Polymeric Systems, Inc.
      d. Sherwin-Williams Company (The).
      e. Sika Corporation.

f. The Dow Chemical Company.
g. Tremco Incorporated.

2. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Silicone, S, P, T, NT: Single-component, 25, pourable, movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pecora Corporation.
   b. Sika Corporation.
   c. The Dow Chemical Company.
   d. Tremco Incorporated.
2. Standard: ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

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

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout or silicone sealant, 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.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs 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 or silicone sealant, seal the space around outside of sleeves.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

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

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 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
   2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above and below Grade:
      a. Sleeves with waterstops.
         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. Sleeves with waterstops.
         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. Sleeves with waterstops.
   4. Interior Partitions:
      a. Sleeves without waterstops.

END OF SECTION 22 05 17

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SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. BrassCraft Manufacturing Co.; a Masco company.
   2. Dearborn Brass.
   3. Jones Stephens Corp.
   4. Keeney Manufacturing Company (The).
   5. Mid-America Fittings, LLC; A Midland Industries Company.

2.2 ESCUTCHEONS

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

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

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

D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

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

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 22 05 18

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Liquid-in-glass thermometers.
2. Thermowells.
3. Pressure gages.
4. Gage attachments.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trerice
2. Dwyer
3. Moeller Instrument
4. Weiss Instruments

B. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle 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, 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. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Plastic; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective 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, 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.

D. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle 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 and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, 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.

E. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Plastic; 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle 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 and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, 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.

2.2 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Emerson
   2. Ashcroft
   3. Swagelok
   4. Omega Engineering

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

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

2.3 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Emerson
   2. Ashcroft
   3. Swagelok
   4. Omega Engineering

B. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Standard: ASME B40.100.
   2. Case: Liquid-filled Open-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
   3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   4. Pressure Connection: Brass, with NPS 1/4, 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 or plastic.
   9. Ring: Metal.
   10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

11. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
12. Movement: Mechanical, with link to pressure element and connection to pointer.
13. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi].
14. Pointer: Dark-colored metal.
15. Window: Glass or plastic.
16. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch Insert dimension nominal diameter with back flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
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 or plastic.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
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 or plastic.
9. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Emerson
2. Ashcroft
3. Swagelok
4. Omega Engineering

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

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install 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 thermometers in the following locations:
   1. Inlet and outlet of each water heater.
   2. Inlets and outlets of each domestic water heat exchanger.
   3. Inlet and outlet of each domestic hot-water storage tank.

K. Install pressure gages in the following locations:
   1. Building water service entrance into building.
   2. Inlet and outlet of each pressure-reducing valve.
   3. Suction and discharge of each domestic water pump.

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

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

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
1. Liquid-filled, bimetallic-actuated type.
2. Metal case, compact industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
1. Liquid-filled, bimetallic-actuated type.
2. Metal case, compact industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
1. Liquid-filled, bimetallic-actuated type.
2. Metal case, compact industrial-style, liquid-in-glass type.

D. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:
1. Liquid-filled, bimetallic-actuated type.
2. Metal case, compact industrial-style, liquid-in-glass type.

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

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

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

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
1. Liquid-filled Open-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
1. Liquid-filled Open-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

METERS AND GAGES FOR PLUMBING PIPING

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

END OF SECTION 22 05 19

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SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Brass ball valves.
2. Bronze ball valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
7. ASME B16.34 for flanged and threaded end connections
8. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

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

F. Valve Actuator Type:
1. Gear Actuator: For quarter-turn valves NPS 4and larger.
2. Hand Lever: For quarter-turn valves smaller than NPS 4.

G. Valves in Insulated Piping:
1. Provide 2-inchextended neck stems.
2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Crane Fluid Systems; Crane Co.
   c. Hammond Valve.
   d. Jenkins Valves; a Crane Co. brand.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Stockham; a Crane Co. brand.
   h. WATTS; A Watts Water Technologies Company.
   i. Zurn Industries, LLC.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig
4. Body Design: Two-piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Blowout-proof Stainless Steel.
9. Ball: Stainless Steel.
10. Trim: Stainless steel.
11. Port: Full.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Stainless Steel Trim, Soldered Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Crane Fluid Systems; Crane Co.
   c. Hammond Valve.
   d. Jenkins Valves; a Crane Co. brand.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Stockham; a Crane Co. brand.
   h. WATTS; A Watts Water Technologies Company.
   i. Zurn Industries, LLC.

2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two-piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Blowout-proof Stainless Steel.
9. Ball: Stainless Steel.
10. Port: Full.

2.4 STAINLESS STEEL BALL VALVES

A. Stainless Steel Ball Valves, Two Piece with Full Port, Threaded:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Fluid Systems; Crane Co.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Stockham; a Crane Co. brand.
h. WATTS; A Watts Water Technologies Company.
i. Zurn Industries, LLC.
2. Standard: MSS SP-110.
3. Class: #150
4. CWP Rating: 200 psig.
5. Body Design: Split body.
6. Body Material: Type 316 stainless steel.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Type 316 stainless steel.
10. Ball: Type 316 stainless steel.
11. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

C. 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.

D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

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

B. Provide support to piping adjacent to valves such that no force is forced upon valves.

C. Locate valves for easy access.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

H. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.

B. Select valves with the following end connections:
1. For Copper Tubing, NPS 2and Smaller: Soldered ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4:Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5and Larger: Flanged ends.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:
1. Brass ball valves, two-piece, lead free, full port, bronze/stainless-steel trim, stainless-steel ball and blowout-proof stainless-steel stem, and RPTFE seats. Provide with solder-joint ends.

2. Bronze ball valves, two-piece, lead free, full port, bronze/stainless-steel trim, stainless-steel ball and blowout-proof stainless-steel stem, and RPTFE seats. Provide with solder-joint ends.

B. Pipe NPS 2-1/2and Larger:
1. Steel ball valves, Class 150 with full port.

END OF SECTION 22 05 23.12

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SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze, swing check valves.
   2. Bronze, swing check valves, press ends.

1.2 ACTION SUBMITTALS

A. Product data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges for metric standard piping.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   5. ASME B16.18 for cast-copper solder joint.
   6. ASME B16.22 for wrought copper solder joint.
   7. ASME B16.51 for press joint.
   8. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for groove-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

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

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

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE, SWING CHECK VALVES

A. Bronze, Swing Check Valves with Bronze Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Fluid Systems; Crane Co.
c. Jenkins Valves; a Crane Co. brand.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Stockham; a Crane Co. brand.
2. Standard: MSS SP-80, Type 3.
3. CWP Rating: 200 psig
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See valve schedule articles.
7. Disc: Bronze.

B. Bronze, Swing Check Valves with Nonmetallic Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Fluid Systems; Crane Co.
c. Jenkins Valves; a Crane Co. brand.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Stockham; a Crane Co. brand.
2. Standard: MSS SP-80, Type 4.
3. CWP Rating: 200 psig
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See valve schedule articles.
7. Disc: PTFE.

C. Bronze, Swing Check Valves with Bronze Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Fluid Systems; Crane Co.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corp.
2. Standard: MSS SP-80, Type 3.

3. CWP Rating: 300 psig
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See valve schedule articles.
7. Disc: Bronze.

D. Bronze, Swing Check Valves with Nonmetallic Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Fluid Systems; Crane Co.
   b. FNW; Ferguson Enterprises, Inc.
   c. Jenkins Valves; a Crane Co. brand.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Red-White Valve Corp.
   g. Stockham; a Crane Co. brand.
2. Standard: MSS SP-80, Type 4.
3. CWP Rating: 300 psig
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See valve schedule articles.
7. Disc: PTFE.

PART 3 - EXECUTION

3.1 INSTALLATION OF VALVES

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

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves so that stems are horizontal or slope upward from centerline of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.

I. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.2 ADJUSTING

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

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Pump-Discharge Check Valves:
      a. NPS 2and Smaller: Bronze, swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2and Larger for Domestic Water: Iron, swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.
      c. NPS 2-1/2and Larger for Sanitary Waste and Storm Drainage: Iron, swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:
   1. For Copper Tubing, NPS 2and Smaller: Threaded, soldered, or press-end connections.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flange or threaded.
   3. For Copper Tubing, NPS 5and Larger: Flange.
   4. For Steel Piping, NPS 2 and Smaller: Threaded.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 Flange or threaded.
   6. For Steel Piping, NPS 5and Larger: Flange.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:
   1. Bronze, swing check valves with nonmetallic disc, Class 150, with soldered or threaded end connections.
   2. Bronze, swing check valves with press-end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron, swing check valves with nonmetallic-to-metal seats, Class 125, with threaded or flange end connections.

END OF SECTION 22 05 23.14

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

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:
1. Section 220516 “Expansion Fittings and Loops for Plumbing Piping” for pipe guides and anchors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated Design Submittal: For hangers and supports for plumbing piping and equipment, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design for Structural Performance: Engage a qualified professional engineer to design hangers and supports for plumbing piping and equipment. The professional engineer must confirm that the capacity of the existing structure is adequate where it will be used to support piping and equipment. Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and

stresses within limits and under conditions according to the Building Code of New York State.

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. Professional Engineering Qualifications: A professional engineer who is legally qualified to practice in New York State and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of systems or assemblies that are similar to those indicated for this Project in material, design, and extent.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
   3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
   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 and Tube 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.

2.3 TRAPEZE PIPE HANGERS

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

B. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from type 304 stainless steel-steel shapes, stainless-steel hanger rods, nuts, saddles, and U-bolts in corrosive areas.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Buckaroos, Inc.
   2. Carpenter & Paterson, Inc.
   3. KB Enterprise.
   4. National Pipe Hanger Corporation.
   5. Pipe Shields Inc.

6. Piping Technology & Products, Inc.
7. Rilco Manufacturing Co., Inc.
8. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 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 anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Indoor Applications: Zinc-coated] or stainless steel.
2. Outdoor Applications: Stainless steel.

2.6 PIPE-POSITIONING SYSTEMS

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

2.7 EQUIPMENT SUPPORTS

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

2.8 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
   2. Field fabricated from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

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

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

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
1. Attach clamps and spacers to pipe.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.5 ADJUSTING

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

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

3.6 PAINTING

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas 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 A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel 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. All under-slab piping shall be supported at 5’-0 maximum on center and at all joints with a stainless steel hanger system. Coordinate with GC.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

PIPE HANGER SUPPORT SCHEDULE			
PIPE SIZE	MAXIMUM HORIZONTAL HANGER SPACING (FEET)		
	COPPER PIPE (FT.)	STEEL PIPE (FT.)	MINIMUM ROD SIZE (INCHES)
1/2	5	6	3/8
3/4	5	6	3/8
1	6	6	3/8
1 1/4	6	6	3/8
1 1/2	6	6	3/8
2	7	7	3/8
2 1/2	8	10	1/2
3	10	10	1/2
4	10	10	5/8
6	10	10	3/4

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

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

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

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

END OF SECTION 22 05 29

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SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.

B. Related Requirements:
   1. Section 221116 "Domestic Water Piping" for labeling requirements.
   2. Section 221319 "Sanitary Waste and Vent Piping" for labeling requirements.
   3. Section 221413 "Facility Storm Drainage Piping" for labeling requirements.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Seton Namplate Corp.
      b. Emed Co.
      c. Panduit Corp.
      d. W.H. Brady Co.
   2. Material and Thickness: Brass, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
   3. Letter and Background Color: As indicated for specific application under Part 3.
   4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.
   6. Fasteners: Stainless steel rivets or self-tapping screws.

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

B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Seton Namplate Corp.
b. Emed Co.
c. Panduit Corp.
d. W.H. Brady Co.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Seton Namplate Corp.
2. Emed Co..
3. Panduit Corp.
4. W.H. Brady Co..

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

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

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

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION, GENERAL REQUIREMENTS

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

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

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

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background].

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. 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. Within 3 ft. of each valve and control device.

2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:
1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
4. Sanitary Waste and Storm Drainage Piping: White letters on a black background.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Domestic chilled-water piping for drinking fountains.
   5. Roof drains and rainwater leaders.
   6. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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, equipment connections, and access panels.
   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.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material test reports.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
   1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

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

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

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

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

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.

G. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
   1. Manufacturers: provide products by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Knauf Insulation.
      c. Manson Insulation Inc.
      d. Owens Corning.
   2. Preformed Pipe Insulation: Type I, Grade A, unfaced.
   3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
   4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials, self-seal.
   1. Manufacturers: provide products by the following or:
      a. Armacell LLC.
      b. Aeroflex USA
      c. Thermaflex

2.3 ADHESIVES

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

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Foster Brand; H. B. Fuller.
      b. Owens Corning
      c. GLT Products

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
   1. Manufacturers: provide products by one of the following:
      a. Aeroflex USA.
      b. Armacell LLC.
      c. Foster Brand; H. B. Fuller.
      d. K-Flex USA.

2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F.
4. Service Temperature Range: 40 to 200 deg F.
5. Color: Black.

D. Glass-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

E. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
1. Manufacturers: provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: provide products by one of the following:
a. Johns Manville; a Berkshire Hathaway company.
b. Proto Corporation.
c. Speedline Corporation.
d. The Dow Chemical Company.

2.4 MASTICS AND COATINGS

A. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Knauf Insulation.
d. Mon-Eco Industries, Inc.
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: White.

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.

c. Knauf Insulation.
d. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.
d. Owens Corning.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 58 to plus 176 deg F.
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
   4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   5. PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, 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 D1784, 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, provide products by one of the following:
      a. Airex Manufacturing Inc.
      b. Johns Manville; a Berkshire Hathaway company.
      c. P.I.C. Plastics, Inc.
      d. Proto Corporation.
      e. Speedline Corporation.
   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.
      b. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
      c. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.

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

D. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. 3M.
b. Foster Brand; H. B. Fuller.
c. Ideal Tape Co., Inc., an American Biltrite Company.
2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
4. Aluminum Finish: Embossed.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. 3M Industrial Adhesives and Tapes Division.
b. Aeroflex USA.
c. Avery Dennison Corporation, Specialty Tapes Division.
d. Ideal Tape Co., Inc., an American Biltrite Company.
e. Knauf Insulation.
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 C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.
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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Industrial Adhesives and Tapes Division.
   b. Ideal Tape Co., Inc., an American Biltrite Company.
   c. Nitto Denko
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.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.
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.

2.9 SECUREMENTS

A. Bands:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.
   c. It Straps On, Inc.
2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

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

C. Wire: 0.080-inch nickel-copper alloy.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the:
      a. C & F Wire Products.
      b. Johns Manville; a Berkshire Hathaway company.
      c. RPR Products, Inc.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Buckaroos, Inc.
      b. MVG Molded Products.
      c. McGuire Manufacturing.
      d. Plumberex Specialty Products, Inc.
      e. ProFlo; a Ferguson Enterprises, Inc. brand.
      f. Truebro; IPS Corporation.
      g. Zurn Industries, LLC.
      h. Oatey Co.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProFlo; a Ferguson Enterprises, Inc. brand.
      b. Truebro; IPS Corporation.
      c. Zurn Industries, LLC.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of 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 of 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 tradesman 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.

3.2 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 of 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, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) 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 storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the contract documents.

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 attached to structure with vapor-barrier mastic.

3. Install insert materials and 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, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, in accordance with 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.

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 in similar fashion 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.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.

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

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

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

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078400 "Firestopping."

3.4 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 below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered or routed fittings made from same material and density as that of 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 that 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 that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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 2 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, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
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.

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 that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 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.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

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

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.

2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF GLASS-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 jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with 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 prefabricated 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 glass-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 prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated 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 prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated 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.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

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

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

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

3.8 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Perform tests and inspections.

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

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 PIPING INSULATION SCHEDULE, GENERAL

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

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

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 and Smaller: Insulation shall use of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
   2. NPS 1-1/4 and Larger: Insulation shall use of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall use of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2 and Larger: Insulation shall use of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

C. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall use of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall use of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. All Pipe Sizes: Insulation shall use of the following:
      a. Flexible Elastomeric: 1/2 inch thick.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

G. Hot Service Drains:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

H. Hot Service Vents:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material in areas where insulation is subject to damage. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Concealed:
1. None.

C. Piping, Exposed:
1. PVC: 20 mils thick.

D. All Metallic Piping within corrosive areas, concealed and exposed:
1. All insulated piping shall utilize insulation with a factory applied vapor barrier, along with a field applied PVC jacket.
2. PVC: 30 mils thick.

END OF SECTION 22 07 19

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Copper tube and fittings - domestic water.
2. Ductile-iron pipe and fittings - domestic water.
3. Piping joining materials - domestic water.
4. Transition fittings - domestic water.
5. Dielectric fittings - domestic water.

1.2 ACTION SUBMITTALS

A. Product data.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with NYS Plumbing Code, the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.

C. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Appurtenances for Grooved-End Copper Tubing:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International.
   b. Grinnell Mechanical Products.
   c. Shurjoint Piping Products.
   d. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:
   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating: 300 psig (2070 kPa).

2.4 DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER

A. Mechanical-Joint, Ductile-Iron Pipe:

B. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

C. Appurtenances for Grooved-End, Ductile-Iron Pipe:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1) U.S. Pipe
   2) American Cast Iron Pipe Company
   3) McWane Ductile
   4) Shurjoint Piping Products.
   5) Victaulic Company.
2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
   a. AWWA C606 for ductile-iron-pipe dimensions.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.

2.5 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:
1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

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

2.6 TRANSITION FITTINGS - DOMESTIC WATER

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

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

C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cascade Waterworks Mfg. Co.
b. Dresser Pipeline Solutions.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries, Inc.
e. Jay R. Smith Mfg. Co; a division of Morris Group International.
f. Smith-Blair, a Xylem brand.
g. Viking Johnson.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

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

B. Dielectric Unions - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. A.Y. McDonald Mfg. Co.

b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. HART Industrial Unions, LLC.
d. Jomar Valve.
e. Matco-Norca.
f. WATTS; A Watts Water Technologies Company.
g. Zurn Industries, LLC.

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

C. Dielectric Flanges - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Capitol Manufacturing Company.
b. GF Piping Systems: Georg Fischer LLC.
c. Matco-Norca.
d. WATTS; Watts Water Technologies Company.
e. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Advance Products & Systems, LLC.
b. CALPICO, Inc.
c. GPT; a division of EnPRO Industries.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Phenolic, Temperature Rating: 225 deg F.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil; an ASC Engineered Solution.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. Matco-Norca.
d. Sioux Chief Manufacturing Company, Inc.
e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.

5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING 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 and unions may be used for aboveground piping joints unless otherwise indicated.

C. Grooved-end piping and grooved mechanical joints for domestic water systems are permitted only in mechanical rooms provided with floor drains and in exterior installations where specifically indicated.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller is to be the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) is to be the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), is to be the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.
   2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

3.2 EARTHWORK

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

3.3 INSTALLATION OF PIPING

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

B. Install valves in accordance with the following:
   1. Section 220523.12 "Ball Valves for Plumbing Piping."
   2. Section 220523.14 "Check Valves for Plumbing Piping."

C. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

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

E. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

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

G. 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.

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

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

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

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gauges for Plumbing Piping."

O. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."

P. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

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

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

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

3.4 JOINT CONSTRUCTION

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

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

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

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

F. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

H. Joint Construction for Grooved-End Steel Piping: Make joints in accordance with AWWA C606. Square cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

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

3.5 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

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

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

3.6 INSTALLATION OF DIELECTRIC FITTINGS

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

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

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

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

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

3.8 PIPING CONNECTIONS

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

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

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

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system in accordance with either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

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

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

3.11 ADJUSTING

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

3.12 FIELD QUALITY CONTROL

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

b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 100 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

END OF SECTION 22 11 16

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SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers for domestic water piping.
7. Hose bibbs.
8. Drain valves.
9. Water-hammer arresters.
10. Flexible Connectors
11. Air Vents

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

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

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ames Co.
2. Apollo Valves by Conbraco Industries, Inc.
3. Conbraco Industries, Inc.
4. FEBCO; SPX Valves & Controls.
5. Sioux Chief.
6. Watts Industries, Inc.; Water Products Div.
7. Woodford Manufacturing Company.
8. Zurn Plumbing Products

C. Standard: ASSE 1001.

D. Size: NPS 1/4 to NPS 3, as required to match connected piping.

E. Body: Bronze.

F. Inlet and Outlet Connections: Threaded.

G. Finish: Rough bronze.

H. Hose-Connection Vacuum Breakers:

I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ames Co.
2. Apollo Valves by Conbraco Industries, Inc.
3. Conbraco Industries, Inc.
4. FEBCO; SPX Valves & Controls.
5. Sioux Chief.
6. Watts Industries, Inc.; Water Products Div.
7. Woodford Manufacturing Company.

8. Zurn Plumbing Products

J. Standard: ASSE 1011.

K. Body: Bronze, nonremovable, with manual drain.

L. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

M. Finish: Rough bronze.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide Watts Industries, Inc.; Water Products Div. Model 909 or equivalent products by one of the following:
   a. Apollo Valves by Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Watts Industries, Inc.; Water Products Div.; Model 909
   d. Zurn Plumbing Products Group; Wilkins Div.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Size: Refer to Schedule.
5. Design Flow Rate: Refer to Schedule.
6. Body: Bronze for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:
   a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.

5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.
6. Accessories:
    a. Integral, removable stainless steel strainer.
    b. Outlet pressure range to match operating conditions.
    c. Stainless steel trim.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. ITT Industries; Bell & Gossett Div.
    c. Taco, Inc.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries).
    b. POWERS; A Watts Water Technologies Company.
    c. Symmons Industries, Inc.
    d. WATTS; A Watts Water Technologies Company.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories:
    a. Integral Check stops on hot- and cold-water supplies
    b. Adjustable, temperature-control handle.
    c. Tamper resistant locking mechanism.
    d. Integral Strainers.
    e. Fail-safe hot water shutoff upon cold water supply failure.
8. Tempered-Water Setting:110 deg F (adjustable).
9. Valve Finish: Rough bronze.

B. Emergency Fixture Thermostatic Mixing Valves (TMV-EF):

1. Acceptable Manufacturers:
   a. Powers
   b. Leonard Valve
   c. Lawler Manufacturing
   d. Bradley
   e. Guardian Equipment
2. Standard: ANSI Z358.1.
3. Type: Thermostatically controlled emergency fixture mixing valve.
4. Pressure Rating: 125 psig minimum.
5. Material: Bronze body with corrosion-resistant internal components.
6. Valve Performance:
   a. Maintain outlet temperature within +/- 3 deg F.
   b. Fail-safe protection upon loss of cold-water supply.
   c. Integral check valves and inlet strainers.
   d. High-flow capacity suitable for emergency shower and eyewash service.
7. Tempered Water Setting: 85 deg F.
8. Connections: Threaded or flanged as required by valve size.
9. Cabinet: Stainless steel where recessed installation is indicated.
10. Valve Finish: Rough bronze.

C. Primary, Thermostatic, Water Mixing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lawler Manufacturing Company, Inc.
   b. POWERS; A Watts Water Technologies Company.
   c. Symmons Industries, Inc.
   d. WATTS; A Watts Water Technologies Company.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories:
   a. Integral inlet check stops.
   b. Outlet temperature adjustment.
   c. Thermometers on hot-, cold-, and mixed water piping.
   d. Outlet shutoff valve.
   e. Faile-safe hot-water shutoff upon cold-water supply failure.
8. Tempered-Water Setting: 125 deg F.
9. Valve Finish: Rough bronze.
10. Piping Finish: Copper.

D. Primary, Electronic, Water Mixing Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Caleffi North America.

c. Leonard Valve Company.
d. POWERS; A Watts Water Technologies Company.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Factory assembled, exposed-mounted, electronically controlled digital water mixing valve system.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or solder joint inlets and outlet.
7. Accessories:
   a. Automatic temperature modulation.
   b. Digital user interface.
   c. BAS integration capability.
   d. Integral thermometers.
   e. Automatic hot-water recirculation optimization.
   f. Integral check valves and inlet strainers.
   g. Automatic hot-water shutoff upon cold-water supply failure.
   h. Alarm capability for:
      1) High temperature.
      2) Low temperature.
      3) Sensor Failure.
      4) Loss of recirculation.
      5) Valve failure.
8. Temperature Control Performance:
   a. Maintain outlet temperature within plus or minus 2 deg F.
   b. Adjustable setpoint range from 80 deg F to 140 deg F minimum.
9. Communication Protocol:
   a. BACnet IP.
10. Electrical Characteristics:
    a. 120 V, single phase, 60 Hz.
    b. Battery backup.
11. Tempered water setting: 125 deg F.
12. Valve finish: Rough Bronze.
13. Provide manufacturer startup and commissioning services.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
   2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
   3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   4. Screen: Stainless steel with round perforations, unless otherwise indicated.
   5. Perforation Size: 0.094 inch.
   6. Drain: Pipe plug.
   7. Perforation Size:
      a. Strainers NPS 2 and Smaller: 0.020 inch.

b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
c. Strainers NPS 5 and Larger: 0.10 inch.

8. Drain: Factory-installed, hose-end drain valve.
9. Strainers NPS 2-1/2 and larger with flanged strainer screen retainers, wire mesh liner, full sized nipple, and ball valve at drain connection, reducer and adapter for 5/8" hose.

2.9 HOSE BIBBS

A. Hose Bibbs:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucet.
b. Nibco.
c. T.S. Brass
d. Watts Regulator.
e. Woodford.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral or field-installation, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation: Wheel handle.
13. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 DRAIN VALVES

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

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      d. PPP Inc.
      e. Sioux Chief Manufacturing Company, Inc.
      f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      g. Tyler Pipe; Wade Div.
      h. Watts Drainage Products Inc.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASSE 1010 or PDI-WH 201.
   3. Type: Metal bellows or copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Metraflex, Inc.
   3. Falcon Stainless

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 250 psig.
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 250 psig.
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.13 AIR VENTS

A. Manual Air Vents:
   1. Manufacturers:
      a. Bell & Gossett; No. 4V
      b. Watts Drainage Products Inc.
      c. Caleffi
      d. Taco Comfort Solutions
   2. Type: Loosed key screwdriver stop.

3. Pressure Rating: 150 psi minimum pressure rating at 250 degree F.
4. Material: Stainless steel.
5. Connections: ½" FPT / ¾" MPT.

B. Automatic Air Vents:
1. Manufacturers:
   a. Bell & Gossett; No. 4V
   b. Watts Drainage Products Inc.
   c. Caleffi
   d. Taco Comfort Solutions
2. Material: Brass body with non-ferrous internals.
3. Pressure Rating: 150 psi minimum pressure rating at 240 degree F.
4. Connections: ½" FPT / ¾" MPT.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

D. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve, solenoid valve and pump.

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

F. Drainage-Type, Trap-Seal Primer Device: Install 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.

3.2 PIPING CONNECTIONS

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

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

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

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.

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

3.6 ADJUSTING

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

B. Set field-adjustable flow set points of balancing valves.

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

D. Adjust each pressure vacuum breaker, reduced-pressure-principle backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
   1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
   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 unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 22 11 19

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SECTION 22 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Piping specialties.
   2. Corrugated, stainless steel tubing with associated components.
   3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   4. Pressure regulators. Indicate pressure ratings and capacities.
   5. Service meters. Indicate pressure ratings and capacities. Include supports.
   6. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
   1. Shop Drawing Scale: 1/4 inch per foot.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Certificates:
   1. Welding certificates.

C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

D. Field Quality-Control Submittals:
   1. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

A. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

B. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with the current edition of the New York State Fuel Gas Code (NYSFGC) and all applicable referenced standards and utility requirements.

B. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig.

C. Natural-Gas System Pressure within Buildings:
1. Single Pressure: 0.5 psig or less.

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 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, 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 A234/A234M 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.

2.3 PIPING SPECIALTIES

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

2.5 MANUAL GAS SHUTOFF VALVES

A. 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. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.

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

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Body: Bronze, complying with ASTM B584.
   2. Ball: Chrome-plated bronze.
   3. Stem: Bronze; blowout proof.
   4. Seats: Reinforced TFE; blowout proof.
   5. Packing: Threaded-body packnut design with adjustable-stem packing.
   6. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
   7. CWP Rating: 600 psig.
   8. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 PRESSURE REGULATORS

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

2.7 LABELING AND IDENTIFYING

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect natural-gas piping in accordance with NYS Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

B. Comply with NYS Fuel Gas Code requirements for preventing accidental ignition.

3.2 INSTALLATION OF OUTDOOR PIPING

A. Comply with NYS Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. 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.

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

E. Install pressure gauge upstream and downstream from each service regulator.

3.3 INSTALLATION OF INDOOR PIPING

A. Comply with NYS Fuel Gas Code for installation and purging of natural-gas piping.

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

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.

G. Locate valves for easy access. Do not locate valves within return air plenums.

H. Install piping free of sags and bends.

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

J. Verify final equipment locations for roughing-in.

K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

M. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

N. 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.

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

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

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

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

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

T. Install pressure gauge upstream and downstream from each line regulator. Pressure gauges are specified in Section 220519 "Meters and Gauges for Plumbing Piping."

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

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

3.4 INSTALLATION OF VALVES

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

B. Install underground valves with valve boxes.

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

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

E. Do not install valves in return-air plenums.

3.5 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 in accordance with 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.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPING 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 in accordance with NFPA 70.

C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.8 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Test, inspect, and purge natural gas in accordance with NYS Fuel Gas Code and authorities having jurisdiction.
2. Natural-gas piping will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.10 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping is to be the following:
1. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping is to 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.

3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller is to be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, branch piping NPS 2 and larger is to be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

C. Aboveground, distribution piping is to 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.

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

A. Aboveground, branch piping NPS 1 and smaller is to be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, branch piping NPS 2 and larger is to be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

C. Aboveground, distribution piping is to 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.

3.13 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter are to be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter are to be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe sizes NPS 2 and smaller are to be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger are to be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

E. Valves in branch piping for single appliance are to be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 23 11 23

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SECTION 22 11 23.13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Multiplex, variable-speed booster pumps.

B. Related Requirements:
   1. Section 221123.21 "Domestic Water Pumps" for domestic-water circulation pumps.

1.2 DEFINITIONS

A. PID: Proportional Integral Derivative.

B. VFC: Variable-frequency controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, and dimensions of individual components and profiles.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For booster pumps.

   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.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. GRUNDFOS CBS Inc.
   2. Patterson Pump Company; a Gorman-Rupp company.
   3. Taco Comfort Solutions.
   4. Xylem.

B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

C. Pumps, Vertical, Multistage:
   1. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
   2. Casing: Cast-iron or steel base and stainless-steel chamber.
   3. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
   4. Shaft: Stainless steel.
   5. Seal: Mechanical.
   6. Bearing: Water-lubricated sleeve type.

D. Motors:
   1. Premium efficiency inverter-duty motors.
   2. NEMA rated.
   3. Suitable for operation with integrated variable-frequency drives.
   4. Three phase.
   5. TEFC construction.

E. Piping: Factory-fabricated Type 304 stainless steel headers and manifolds.

F. Valves:
   1. Shutoff Valves NPS 2-1/2 and Larger: lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
   2. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
   3. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

G. Pump Isolation: Components shall permit removal of one pump while maintaining operation of the remaining pump. Each pump shall be provided with:

1. Suction isolation valve.
2. Discharge isolation valve.
3. Discharge check valve.

H. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.

I. Variable-Frequency Drives and Controls:
1. Integrated variable-frequency drive on each pump.
2. Factory-programmed PID pressure control.
3. Automatic lead-lag sequencing.
4. Automatic alternation of lead pump.
5. Automatic staging and destaging.
6. Pump runtime equalization.
7. Dry-run protection.
8. Low Suction pressure protection.
9. High Discharge pressure protection.
10. Motor overload protection.
11. Fault diagnostics and alarm history.
12. Color operator interface mounted on control panel.
13. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to BACnet DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:
    a. On-off status of each pump.
    b. Alarm status.

J. Base: Structural steel.

K. Capacities and Characteristics: Refer to Schedule on sheet P621 for details.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

2.4 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. UL Compliance for Packaged Pumping Systems:
1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."

3. UL 778, "Motor-Operated Water Pumps."

D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Booster-Pump Mounting:
1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

C. Install booster system with minimum manufacturer-recommended service clearances.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Booster-Pump Piping Connections: Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge piping.
1. Install shutoff valves on piping connections to booster-pump suction and discharge piping. Install ball, butterfly, or gate valves same size as suction and discharge piping. Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge piping. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
4. Where installing piping adjacent to booster pumps, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

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

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 FIELD QUALITY CONTROL

A. Testing Agency:
   1. 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 tests and inspections with the assistance of a factory-authorized service representative.
   1. Perform visual and mechanical inspection.
   2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump 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.

F. Verify proper lead-lag sequencing, pressure control operation, alarm functions, and communications functions.

3.8 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.

3.9 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

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

3.10 DEMONSTRATION

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

END OF SECTION 221123.13

SECTION 22 11 23.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. In-line, sealless centrifugal pumps.

B. Related Requirements:
1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, 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:

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 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. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. GRUNDFOS CBS Inc.
2. Taco Comfort Solutions.
3. WILO USA LLC - WILO Canada Inc.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Capacities and Characteristics: Refer to pump schedule on plumbing sheet P621.

D. Pump Construction:
1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: 150 psig minimum .
3. Maximum Continuous Operating Temperature: 220 deg F
4. Casing: Stainless steel, with threaded or companion-flange connections.
5. Impeller: Manufacturer’s standard nonferrous or composite material suitable for potable hot water service.
6. Motor: ECM variable speed type.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."
1. Motor Sizes: Minimum size as indicated.

B. Motors shall be ECM type integral to pump assembly.

2.4 CONTROLS

A. Kitchen Equipment Hot Water Circulation Pumps:
1. Pumps serving the 140 deg F kitchen equipment hot water circulation loop shall utilize factory-integral ECM controls.
2. Provide automatic lead-lag alternation between pumps.
3. Provide automatic standby pump operation upon failure of operating pump.
4. Provide BAS monitoring points where indicated on drawings.

B. Domestic Hot Water Recirculation Pumps:

1. Pumps serving the 125 deg F tempered domestic hot water recirculation loop shall be integrated with the digital mixing valve control system.
2. Coordinate pump operation and control sequences with the digital mixing valve manufacturer.
3. Provide automatic lead-lag alternation between pumps.
4. Provide automatic standby pump operation upon failure of operating pump.
5. Pump operation shall maintain recirculation temperature setpoint established by the digital mixing valve controller.
6. Provide BAS monitoring points where indicated on drawings.

C. Control Interface Requirements:
1. Provide all relays, interfaces, control wiring, and accessories required for proper operation.
2. Coordinate control requirements with Division 26 and Division 23 controls.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF PUMPS

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight. Support piping independently of pumps.
1. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Coordinate controls, interlocks, BAS points, and recirculation temperature control requirements with the digital mixing valve control system and domestic water heating system.

3.5 IDENTIFICATION

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

3.6 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 tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Copper Tube and fittings.
4. PVC pipe and fittings.
5. Specialty pipe fittings.

B. Related Requirements:
1. Section 331313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.2 ACTION SUBMITTALS

A. Product data.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.4 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

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

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

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:
1. Marked with CISPI collective trademark.
2. ASTM A74, service-weight cast iron with asphaltic coating.

C. Compression Gaskets:
1. ASTM C564.
2. Neoprene or synthetic rubber.
3. Specifically manufactured for hub-and spigot cast iron soil pipe and fittings.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:
1. Marked with CISPI collective trademark.
2. ASTM A888 and CISPI 301.
3. Service-weight cast-iron with asphaltic coating.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AB & I Foundry; a part of the McWane family of companies.
b. ANACO-Husky.
c. Charlotte Pipe and Foundry Company.
d. Clamp-All Corp.
e. Dallas Specialty & Mfg. Co.
f. MIFAB, Inc.
g. Tyler Pipe; a subsidiary of McWane Inc.
2. Standards: ASTM C1540.

3. Description: Heavy duty Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, elastomeric sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Mueller Streamline (Mueller Industries)
   2. Cerro Flow Products.
   3. Great Lakes Copper Ltd.

B. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

C. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

D. Hard Copper Tube: ASTM B88, Type L water tube, drawn temper.

E. Copper Pressure Fittings:
   1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. 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.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Charlotte Pipe and Foundry Company.
   2. Cor-Tek; Atkore International.
   3. JM Eagle.

B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

C. Solid-Wall PVC Pipe: ASTM D2665 Schedule 40 drain, waste, and vent.

D. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

E. Adhesive Primer: ASTM F656.

F. Solvent Cement: ASTM D2564.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Shielded, Nonpressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Cascade Waterworks Mfg. Co.
2) Fernco Inc.
3) Mission Rubber Company, LLC; a division of MCP Industries.
b. Standard: ASTM C1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

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

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. 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.
   2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.
   1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
   2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
   3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
   3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground PVC piping in accordance with ASTM D2665.

O. Install underground PVC piping in accordance with ASTM D2321.

P. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
   a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
   b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install drains in sanitary waste gravity-flow piping.
   a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

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

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

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

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

U. Piping Installed in Environmental Air Plenums:
1. Materials installed exposed within environmental air plenums shall comply with the requirements of the New York State Mechanical Code and NFPA 90A.
2. Plastic piping shall not be installed exposed within environmental air plenums unless specifically listed and labeled for such use.
3. Where plastic piping is indicated within plenum spaces, provide plenum-rated piping products and installation methods specifically approved by the piping manufacturer and acceptable to authorities having jurisdiction.
4. Where plenum-rated plastic piping is not permitted, provide cast-iron or copper piping as required to comply with applicable codes.

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hubless, Cast-Iron Soil Piping Coupled Joints:
1. Join hubless cast-iron soil piping using ASTM C1540 heavy-duty couplings in accordance with CISPI 310 and manufacturer's written instructions.

C. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.
2. Install shielded transition couplings where joining dissimilar piping materials.

3.5 VALVE INSTALLATION

A. General valve installation requirements for general-duty valve installation are specified in the following Sections:
1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."
3. Section 220523.15 "Gate Valves for Plumbing Piping."

B. Shutoff Valves:
1. Install full-port ball valve for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".

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 waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste 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 waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."

7. Equipment: Connect waste piping as indicated.
   a. Use flanges instead of unions for connections NPS 2-1/2 and larger.

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

E. Make connections in accordance with the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 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 waste and vent piping in accordance with 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.
      a. 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 waste and vent piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.

   3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. 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.
   a. 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.
   b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
   c. Air pressure must remain constant without introducing additional air throughout period of inspection.
   d. 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.

3.10 CLEANING AND PROTECTION

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

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

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

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

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

B. Aboveground, soil and waste piping NPS 4 and smaller are to be any of the following:
   1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   2. Cast-iron soil pipe and fittings.

C. Aboveground, soil and waste piping NPS 5 and larger are to be any of the following:
   1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   2. Cast-iron soil pipe and fittings.

D. Underground, soil, waste, and vent piping NPS 4 and smaller are to be any of the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Cast-iron soil pipe and fittings.

E. Underground, soil and waste piping NPS 5 and larger are to be any of the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Cast-iron soil pipe and fittings.

F. Aboveground pumped sanitary drainage piping shall be:
1. Type L copper tube, wrought copper fittings, and soldered joints.

G. Aboveground grease waste piping shall be:
1. Hubless cast iron soil pipe and fittings with ASTM C1540 heavy duty couplings.

H. Underground grease waste piping shall be:
1. Hub-and spigot cast iron soil pipe and fittings with compression gasket joints.

I. Piping installed exposed within environmental air plenums shall comply with applicable plenum requirements of the New York State Mechanical Code and NFPA 90A. Provide plenum-rated piping products where required. Standard PVC DWV piping shall not be installed exposed within environmental air plenums unless specifically listed for such use.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Cleanouts.
2. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:
1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 077200 "Roof Accessories" for preformed flashings.
3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
5. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Show fabrication and installation details for frost-resistant vent terminals.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

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

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. Tyler Pipe; a subsidiary of McWane Inc.
      e. WATTS; A Watts Water Technologies Company.
      f. Zurn Industries, LLC.
   2. Standard: ASME A112.36.2M.
   3. Size: Same as connected drainage piping.
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
   5. Closure: Countersunk or raised-head, brass plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. Sioux Chief Manufacturing Company, Inc.
      e. WATTS; A Watts Water Technologies Company.
      f. Zurn Industries, LLC.
   2. Standard: ASME A112.36.2M for adjustable housing cleanout.
   3. Size: Same as connected branch.
   4. Type: Adjustable housing.
   5. Body or Ferrule: Cast iron.
   6. Clamping Device: Not required.
   7. Outlet Connection: Inside calk.
   8. Closure: Brass plug with straight threads and gasket].
   9. Adjustable Housing Material: Cast iron with threads.
   10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
   11. Frame and Cover Shape: Round.
   12. Top-Loading Classification: Heavy Duty.
   13. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. WATTS; A Watts Water Technologies Company.

e. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
   a. Brass.
   b. Countersunk or raised head.
   c. Drilled and threaded for cover attachment screw.
   d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.
7. Wall Access, Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
1. Description: Shop or field fabricate from ASTM A74, 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 C564 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: 4-inch-minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Floor-Drain, Inline Trap Seal:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Green Drain, Inc.
   b. Jay R. Smith Mfg Co; a division of Morris Group International.
   c. Josam Company.
   d. MIFAB, Inc.
   e. RectorSeal Plumbing; A CSW Industrials Company.
   f. Zurn Industries, LLC.
2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

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 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.
1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Assemble open drain fittings and install with top of hub 1 inch above floor.

F. Install deep-seal traps on floor drains and other waste outlets, if indicated.

G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

I. Install sleeve, sleeve seals with each riser, and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install wood-blocking reinforcement for wall-mounting-type specialties.

L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.3 LABELING AND IDENTIFYING

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

3.4 PROTECTION

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

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 13 19.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Floor drains.
   2. Floor sinks.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. WATTS; A Watts Water Technologies Company.
      e. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
11. Sediment Bucket: Not required].
12. Top or Strainer Material: Nickel bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: 6 inch diameter
16. Top Loading Classification: Heavy Duty.
17. Funnel: Not required.
18. Inlet Fitting: Not required.
19. Trap Material: Cast iron.
20. Trap Pattern: Standard P-trap.
21. Trap Features: Not required.

B. Cast-Iron Floor Drains for Mechanical Spaces:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Josam Company.
   c. MIFAB, Inc.
   d. WATTS; A Watts Water Technologies Company.
   e. Zurn Industries, LLC.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Epoxy-coated cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom, no-hub connection.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Epoxy coating.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Stainless steel.
13. Top of Body and Strainer Finish: Stainless steel.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: 6 inch diameter.
16. Top Loading Classification: Heavy Duty.
17. Funnel: Not required.
18. Inlet Fitting: Not required.
19. Trap Material: Cast iron.

20. Trap Pattern: Standard P-trap.
21. Trap Features: Not required.

C. Cast-Iron Floor Drains for Finished Spaces:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. WATTS; A Watts Water Technologies Company.
e. Zurn Industries, LLC.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Dura-Coated cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Not required.
7. Clamping Device: Required.
8. Outlet: Bottom, no-hub connection.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Dura-Coated.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Polished nickel bronze.
13. Top of Body and Strainer Finish: Polished nickel bronze.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: 6 inch diameter.
16. Top Loading Classification: Light Duty.
17. Funnel: Not required.
18. Inlet Fitting: Not required.
19. Trap Material: Cast iron.
20. Trap Pattern: Standard P-trap.
21. Trap Features: Not required.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Commercial Enameling Company.
b. Jay R. Smith Mfg Co; a division of Morris Group International.
c. WATTS; A Watts Water Technologies Company.
d. Wade; a subsidiary of McWane Inc.
e. Zurn Industries, LLC.
f. Josam Company.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required, with seepage holes.

6. Clamping Device: Required.
7. Outlet: Bottom, no-hub, connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Not required.
10. Internal Strainer: Dome.
11. Internal Strainer Material: Aluminum.
12. Top Grate Material: Cast iron, loose.
13. Top of Body and Grate Finish: Nickel bronze.
14. Top Shape: Square.
15. Dimensions of Top Grate: 8 inches square.
16. Top Loading Classification: No traffic.
17. Funnel: Not required.

2.4 TRENCH DRAINS

A. Cast Iron trench Drains
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Commercial Enameling Company.
   b. Jay R. Smith Mfg Co; a division of Morris Group International.
   c. WATTS; A Watts Water Technologies Company.
   d. Wade; a subsidiary of McWane Inc.
   e. Zurn Industries, LLC.
   f. Josam Company.
2. Standard: ASME A112.6.3
3. Pattern: Trench drain.
4. Body Material: Dura-Coated cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Dura-Coated.
11. Sediment Bucket: Not required.
12. Top or Grate Material: Ductile iron.
13. Top of Body and Grate Finish: Dura-Coated.
14. Top Shape: Rectangular.
15. Dimensions of Top or Grate: As indicated on Drawings.
16. Top Loading Classification: Heavy Duty.
17. Funnel: Not required.
18. Inlet Fitting: Not required.
19. Trap Material: Cast iron.
20. Trap Pattern: Standard P-trap.
21. Trap Features: Not required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
   3. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
      a. Maintain integrity of waterproof membranes where penetrated.
   5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install open drain fittings with top of hub 1 inch above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

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

3.4 PROTECTION

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

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19.13

SECTION 22 13 23 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interceptors, grease.

1.2 DEFINITIONS

A. FOGs: Fats, oils, greases.

B. FRP: Fiberglass-reinforced plastic.

C. PP: Polypropylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of sanitary waste interceptor.
   1. 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 grease interceptors.
   1. Include plans, elevations, dimensions, service clearances, access requirements, and piping connections.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Piping connections. Include size, location, and elevation of each.
   2. Interface with underground structures and utility services.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.6 FIELD 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 in accordance with 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 INTERCEPTORS, GREASE

A. Interceptors, Grease - Plastic:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. Schier Products Company.
      c. Zurn; Zurn Elkay.
   2. Standard:
      a. PDI G101.
      b. ASME A112.14.3.
   3. PDI Seal: Required.
   4. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food -preparation or -processing wastewater.
   5. Body Material: Rotationally molded polyethylene.
   6. Inlet, Outlet, and Vent Piping Connections: no-hub (hubless) cast iron unless otherwise indicated.
   7. Capacities and Characteristics: Refer to schedule on sheet P621.

2.2 ACCESSIBILITY REQUIREMENTS

A. Grease interceptor location shall permit complete access for inspection, cleaning, maintenance, and pumping.

B. Coordinate final location with Owner and Campus representative.

C. Install interceptor such that routine pump-out and cleaning operations can be performed without removal of building components.

D. Locate interceptor to permit access by grease pumping equipment in accordance with campus requirements.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF SANITARY WASTE INTERCEPTORS

A. Equipment Mounting:

1. Install grease interceptors on cast-in-place concrete equipment base(s).
2. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Set interceptors level and plumb.

C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

D. Set tops of manhole frames and covers flush with finished surface in pavements.

E. Set plastic interceptors level and plumb.

F. Set tops of metal interceptor covers flush with finished surface in pavements.

G. Install grease interceptors, including trapping, venting, and flow-control fitting, in accordance with authorities having jurisdiction and with clear space for servicing.
1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

H. Install grease-removal devices on floor. Install trap, vent, and flow-control fitting in accordance with authorities having jurisdiction.
1. Install control panel adjacent to unit unless otherwise indicated.

I. Install grease interceptor in accordance with manufacturer's written instructions and authority having jurisdiction requirements.
1. Provide required flow-control fitting.
2. Provide vent connection where required by manufacturer.
3. Provide clearances required for cover removal and maintenance.
4. Install cleanout immediately downstream of interceptor if not integral to interceptor assembly.
5. Coordinate final location with Owner and Campus representative.

3.3 PIPING 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."
   1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
   2. Use warning tapes or detectable warning tape over ferrous piping.
   3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Grease interceptors.

3.5 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 221323

SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hub-and-spigot, cast-iron soil pipe and fittings.
   2. Hubless, cast-iron soil pipe and fittings.
   3. PVC pipe and fittings.
   4. Specialty pipe and fittings.

B. Related Requirements:
   1. Section 334100 "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For siphonic roof drainage system. Include calculations, plans, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

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

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AB & I Foundry; a part of the McWane family of companies.

2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:
1. Marked with CISPI collective trademark.
2. ASTM A74, service-weight cast iron with asphaltic coating.

C. Compression Gaskets:
1. ASTM C564.
2. Neoprene or synthetic rubber.
3. Specifically manufactured for hub-and spigot cast iron soil pipe and fittings.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:
1. Marked with CISPI collective trademark.
2. ASTM A888 and CISPI 301.
3. Service-weight cast-iron with asphaltic coating.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AB & I Foundry; a part of the McWane family of companies.
b. ANACO-Husky.
c. Charlotte Pipe and Foundry Company.
d. Clamp-All Corp.
e. Dallas Specialty & Mfg. Co.
f. MIFAB, Inc.
g. Tyler Pipe; a subsidiary of McWane Inc.
2. Standards: ASTM C1540.
3. Description: Heavy duty Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, elastomeric sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Charlotte Pipe and Foundry Company.
2. Cor-Tek; Atkore International.
3. JM Eagle.

B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

C. Solid-Wall PVC Pipe: ASTM D2665 Schedule 40 drain, waste, and vent.

D. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

E. Adhesive Primer: ASTM F656.

F. Solvent Cement: ASTM D2564.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Shielded, Nonpressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Cascade Waterworks Mfg. Co.
2) Fernco Inc.
3) Mission Rubber Company, LLC; a division of MCP Industries.
b. Standard: ASTM C1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

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

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

2. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
a. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install below grade piping at the following minimum slopes unless otherwise indicated:
1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground PVC piping according to ASTM D 2665.

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

P. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
      a. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
   2. Install drains in storm drainage gravity-flow piping.
      a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

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

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

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

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

3.3 JOINT CONSTRUCTION

A. PVC, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in ODs.
   2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

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.
   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   2. Install horizontal backwater valves in pit with pit cover flush with floor.
   3. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

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

E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. 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.
      a. 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.
      a. Expose work that was covered or concealed before it was tested.
   3. Test Procedure:
      a. Test storm drainage piping on completion of roughing-in.

b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

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

C. Piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 CLEANING AND PROTECTION

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

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

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

3.10 PIPING SCHEDULE

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

B. Aboveground storm drainage piping NPS 6 and smaller shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, storm drainage piping NPS 8 and larger shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Underground storm drainage piping NPS 6 and smaller shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Underground, storm drainage piping NPS 8 and larger shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 22 14 13

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. General-purpose roof drains.
2. Multipurpose Drains
3. Deck roof drains
4. Miscellaneous storm drainage piping specialties.
5. Cleanouts.

B. Related Requirements:
1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

1.2 ACTION SUBMITTALS

A. Product Data:
1. General-purpose roof drains.
2. Multipurpose drains.
3. Deck roof drains.
4. Miscellaneous storm drainage piping specialties.
5. Cleanouts.
6. Backwater valves.
7. Trench drains.
8. Channel drainage systems.

1.3 QUALITY ASSURANCE

A. Provide drainage piping specialties are to bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 GENERAL-PURPOSE ROOF DRAINS

A. Cast-Iron Roof Drains:
1. Cast-Iron, medium-Sump, General-Purpose Roof Drains: RD-1.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Jay R. Smith Mfg Co; a division of Morris Group International.
2) Sioux Chief Manufacturing Company, Inc.
3) WATTS; A Watts Water Technologies Company.
4) Zurn; Zurn Elkay.
b. Standard: ASME A112.6.4.

c. Body Material: Cast iron.
d. Dome Material: Polyethylene.
e. Combination flashing ring and gravel stop.
f. Outlet: Bottom.
g. Outlet Type: No-hub.
h. Options:
1) Extension collars.
2) Underdeck clamp.
3) Expansion joint.
4) Sump receiver plate.
5) Perforated Gravel Guard: Stainless steel.

B. Copper Roof Drains:
1. Copper, Sidewall Roof Drains: RD-3
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Marathon Roofing Products.
2) Menzies Metal Products.
3) OMG Roofing Products; a Division of OMG, Inc.
4) Thunderbird Products.
b. Standard: ASME A112.6.4.
c. Drain Body and Flange Material: Copper.
d. Combination flashing ring and gravel stop.
e. Outlet: Horizontal through wall.
f. Outlet Type: No hub.
g. Options:
1) Extension collars.
2) Expansion joint.

2.2 BI-FUNCTIONAL ROOF DRAINS

A. Cast-Iron Bi-Functional Roof Drains:
1. Cast-Iron, Bi-Functional Roof Drain with Integral Overflow Weir: (RD-2)
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Jay R. Smith Mfg Co; a division of Morris Group International.
2) WATTS; A Watts Water Technologies Company.
3) Zurn; Zurn Elkay.
4) Josam Company.
b. Standard: ASME A112.6.4
c. Description: Roof drain assembly designed to provide both primary roof drainage and emergency overflow drainage through a single body utilizing an integral overflow weir.
d. Body Material: Cast iron with factory-applied protective coating.
e. Dome material: Cast Iron.
f. Overflow weir: Integral cast overflow weir

g. Flashing Clamp: Combination flashing ring and gravel stop.
h. Outlet configuration: Side outlet above overflow drainage outlet.
i. Outlet type: No-hub.
j. Overflow Outlet: Bottom.
k. Overflow Outlet type: No-hub.
l. Sump: Manufacturer's standard deep sump suitable for membrane roofing systems.
m. Options:
    1) Extension collars.
    2) Underdeck clamp.
    3) Sump receiver plate.
    4) Adjustable overflow weir where indicated.
    5) Membrane flashing clamp.
    6) Ballast guard or gravel stop as required for roofing system.
    7) Vandal-resistant dome.
    8) Overflow standpipe where indicated.

2.3 DECK ROOF DRAINS

A. Cast-Iron Deck Roof Drains:
1. Cast-Iron, Medium-Sump, Deck Roof Drains (RO-1):
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Jay R. Smith Mfg Co; a division of Morris Group International.
        2) WATTS; A Watts Water Technologies Company.
        3) Zurn; Zurn Elkay.
        4) Josam Company.
    b. Standard: ASME A112.6.4.
    c. Body Material: Cast iron.
    d. Top-Loading Classification: Heavy Duty.
    e. Grate Material: Cast or ductile iron.
    f. Flange: Anchor.
    g. Outlet: Bottom.
    h. Outlet Type: No-hub.
    i. Options:
        1) Clamping device.
        2) Backwater valve.
        3) Grate Finish: Stainless Steel.
        4) Vandal-proof frame and grate.

2.4 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Metal Downspout Nozzles:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. WATTS; A Watts Water Technologies Company.

c. Zurn; Zurn Elkay.
d. Josam Company.

2. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
3. Size: Same as connected downspout.
4. Material: Cast bronze or nickel bronze nozzle and flange.
5. Piping Connection Type: No-hub.
6. Finish: Chrome Plated.
7. Opening Protection: Birdscreen.

2.5 CLEANOUTS

A. Cast-Iron Cleanouts:
1. Cast-Iron Exposed Cleanouts: .
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) MIFAB, Inc.
2) WATTS; A Watts Water Technologies Company.
3) Zurn; Zurn Elkay.
4) Josam Company.
b. Standard: ASME A112.36.2M.
c. Size: Same as connected branch.
d. Body Material: No-hub, cast-iron soil pipe test tee as required to match connected piping.
e. Closure: Countersunk or Raised head, plug.
f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
2. Cast-Iron Exposed Floor Cleanouts:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Jay R. Smith Mfg Co; a division of Morris Group International.
2) Sioux Chief Manufacturing Company, Inc.
3) WATTS; A Watts Water Technologies Company.
4) Zurn; Zurn Elkay.
b. Standard: ASME A112.36.2M.
c. Size: Same as connected branch.
d. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule.
e. Body or Ferrule: Cast iron.
f. Outlet Connection: No-hub.
g. Closure: Brass plug with straight threads and gasket.
h. Adjustable Housing Material: Cast iron with threads.
i. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
j. Frame and Cover Shape: Round.
k. Top Loading Classification: Heavy Duty.
l. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.
m. Options:

1) Clamping device.

3. Cast-Iron Wall Cleanouts:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Jay R. Smith Mfg Co; a division of Morris Group International.
      2) MIFAB, Inc.
      3) WATTS; A Watts Water Technologies Company.
      4) Zurn; Zurn Elkay.
   b. Standard: ASME A112.36.2M. Include wall access.
   c. Size: Same as connected drainage piping.
   d. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
   e. Closure Plug:
      1) Material: Brass.
      2) Head: Countersunk or raised.
      3) Drilled and threaded for cover attachment screw.
      4) Size: Same as, or not more than, one size smaller than cleanout size.
   f. Wall-Access Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
   g. Wall-Access Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.
4. Cast-Iron Test Tees: .
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Jay R. Smith Mfg Co; a division of Morris Group International.
      2) MIFAB, Inc.
      3) WATTS; A Watts Water Technologies Company.
      4) Zurn; Zurn Elkay.
   b. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
   c. Size: Same as connected drainage piping.
   d. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
   e. Closure Plug: Countersunk or raised head,.
   f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.
   1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 18 inches above grade. Secure to building wall.

D. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 ft. for piping NPS 4 and smaller and 100 ft. for larger piping.
   4. Locate cleanouts at base of each vertical storm piping conductor.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install test tees in vertical conductors and near floor.

I. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

J. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
   1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 INSTALLATION OF FLASHING

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 CLEANING

A. Clean piping specialties during installation and remove dirt and debris as work progresses.

3.5 PROTECTION

A. Protect piping specialties during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic and construction work.

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

END OF SECTION 22 14 23

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SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sump pumps - submersible.

1.2 ACTION SUBMITTALS

A. Product Data Submittals:
   1. Construction details, material descriptions, dimensions of individual components and profiles.
   2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Plans, elevations, sections, and mounting details.
   2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
   1. Indicate actual installed items by marking submittals with an arrow or box.

1.4 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 manufacturer's written instructions for handling.

1.5 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUMP PUMPS - SUBMERSIBLE

A. Sump Pumps - Submersible, Fixed Position, Single Seal:
1. Basis of Design: Liberty 280 Series: Available manufacturers offering products that may be incorporated into the Work are the following:
a. A.Y. McDonald Mfg. Co.
b. Crane Pumps & Systems.
c. GRUNDFOS CBS Inc.
d. Glentronics, Inc.
e. Little Giant; a brand of Franklin Electric Co., Inc.
f. Weil Pump; a Wilo Company.
g. Xylem.
2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
4. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, vortex style engineered polymer designed for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
a. Motor Housing Fluid: Oil.
9. Capacities and Characteristics: Refer to Sump Pump Schedule on Contract Documents.
10. Controls, Rod-and-Float Type:
a. Enclosure: NEMA 250, Type 1.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
11. Controls, Float- and Pressure-Switch Type:
a. Enclosure: NEMA 250, Type 1; pedestal 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.
e. Oil Minder: UL Listed and shall be compatible with the sump pump, sump basin, and associated electrical controls. The Oil Minder system shall monitor the sump for a presence of oil and hydrocarbons and shall prevent discharge of oi-contaminated water to the drainage system.

12. 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.

2.3 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.

PART 3 - EXECUTION

3.1 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.2 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform] startup service.
    1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.3 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.4 FIELD QUALITY CONTROL

A. 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.
   5. Pumps and controls will be considered defective if they do not pass tests and inspections.

B. 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 controls and pumps.

END OF SECTION 221429

SECTION 22 31 00 - DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water softeners.
   2. Chemicals.
   3. Water-testing sets.

1.2 ACTION SUBMITTALS

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

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

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Salt for Brine Tanks: Furnish in same form as and at least four times original load, but not less than 1000 lb.
   2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

1.6 COORDINATION

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

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of mineral and brine tanks.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
      d. Attrition loss of resin exceeding 3 percent per year.
      e. Mineral washed out of system during service run or backwashing period.
      f. Effluent turbidity greater and color darker than incoming water.
      g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.
   2. Water Softeners, Warranty Period: From date of Substantial Completion.
      a. Mineral Tanks: Five years.
      b. Brine Tanks: Five years.
      c. Control Valve: One year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

B. Capacities and Characteristics: Refer to schedule on sheet P621

2.2 WATER SOFTENERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ATS
   2. Culligan International Company.
   3. WATTS; A Watts Water Technologies Company.
   4. WaterSoft.

B. Description: Factory-assembled, pressure-type water softener.
   1. Configuration: Twin unit with two mineral tanks and one brine tank.
   2. Mounting: On skids.
   3. Wetted Components: Suitable for water temperatures from 40 to at least 120 deg F.
   4. Mineral Tanks, FRP: Pressure-vessel quality.
      a. Construction: Non-ASME code.
      b. Pressure Rating:150 psig minimum.

c. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
d. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
e. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
f. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers, and arranged for even flow distribution through resin bed.
g. Liner: PE, or other material suitable for potable water.

5. Mineral Tanks, Stainless Steel: Electric welded; pressure-vessel quality.
   a. Construction: Non-ASME code.
   b. Pressure Rating: 150 (1035) psig (kPa) minimum.
   c. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
   d. Handholes: 4 inches (102 mm) round or 4 by 6 inches (102 by 152 mm) elliptical, in top head and lower sidewall of tanks 30 (762) inches (mm) and smaller in diameter.
   e. Manhole: 11 by 15 inches (280 by 380 mm) in top head of tanks larger than 30 (762) inches (mm) in diameter.
   f. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
   g. Finish:
      1) Hot-dip galvanized on exterior and interior of tank after fabrication unless tank is stainless steel.
      2) Exterior of tank spray-painted with rust-resistant prime coat, 2- to 3-mil (0.051- to 0.076-mm) dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil (0.203- to 0.254-mm) dry film thickness.
   h. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
   i. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers, and arranged for even flow distribution through resin bed.
   j. Liner: PE, ABS, or other material suitable for potable water.

6. Controls:
   a. Fully automatic demand-initiated regeneration.
   b. Programmable microprocessor-based control.
   c. Lead/lag duplex operation.
   d. Automatic regeneration sequencing.
   e. Time and flow based regeneration capability.
   f. Nonvolatile memory retention.
   g. LCD display indicating operating status and regeneration cycle.
   h. Capability for alternating operation of duplex units.

7. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
   a. Slow opening and closing, nonslam operation.
   b. Diaphragm guiding on full perimeter from fully open to fully closed.
   c. Isolated, dissimilar metals within valve.
   d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
   e. Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
   f. Sampling cocks for soft water.
   g. Special tools are not required for service.
8. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressure; does not require field adjustments.
   a. Meter Control: Each mineral tank shall be provided with a pulse-output water meter. Pulse meters shall be integrated with controller. Regeneration shall be initiated automatically based on accumulated flow and programmed system capacity.
   b. Demand-Initiated Control:
      1) Single mineral tank is equipped with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Head automatically resets to preset total in gallons for next service run.
      2) Each mineral tank of twin mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to initiate regeneration at preset total in gallons. Head automatically resets to preset total in gallons for next service run. Electrical lockout prevents simultaneous regeneration of both tanks.
      3) Each twin mineral-tank unit is equipped with automatic-reset-head water meter, in common outlet header, that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Automatically repeats with other tank. Electrical lockout prevents simultaneous regeneration of both tanks.
      4) Each mineral tank of multiple mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to automatically regenerate at preset total in gallons. Head automatically resets to preset total in gallons for next service run. Electrical lockout prevents simultaneous regeneration of more than one tank.
      5) Each multiple mineral-tank unit is equipped with automatic-reset-head water meter, in common outlet header, that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tanks. Automatically repeats with other tanks. Electrical lockout prevents simultaneous regeneration of more than one tank.
9. Brine Tank: Combination measuring and wet-salt storing system.

a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawal and freshwater refill.
c. Size: Large enough for at least four regenerations at full salting.

10. Factory-Installed Accessories:
a. Piping, valves, tubing, and drains.
b. Sampling cocks.
c. Main-operating-valve position indicators.
d. Pulse water meters.

2.3 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene, ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
1. Exchange Capacity: Manufacturer's standard high-capacity ion-exchange resin as required to achieve scheduled system capacity.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.
1. Form: Processed, plain salt pellets.

2.4 WATER-TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

C. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, where indicated.

D. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

E. Hydrostatically test mineral tanks before shipment to a minimum of one and one-half times the pressure rating.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF WATER SOFTENERS

A. Equipment Mounting:
   1. Install water softeners on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
   3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

C. Install brine lines and fittings furnished by equipment manufacturer, but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water-testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
   1. Metal general-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
   2. Plastic valves are specified in Section 221116 "Domestic Water Piping."
   3. Exception for water softeners with factory-installed shutoff valves at locations indicated.

D. Install pressure gauges on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gauges are specified in Section 220500 "Common Work Results for Plumbing."
   1. Exception for water softeners with factory-installed pressure gauges at locations indicated.
   2. Exception for household water softeners.
   3. Exception for water softeners in hot-water service.

E. Install valved bypass in water piping around water softeners.
   1. Metal general-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
   2. Plastic valves are specified in Section 221116 "Domestic Water Piping."
   3. Water piping is specified in Section 221116 "Domestic Water Piping."
   4. Exception for water softeners in hot-water service.

F. Install indirect wastes to spill into open drains or pit with drain.

G. Install water softener system with full-size three-valve bypass arrangement.

H. Install unions or flanged connections at equipment to permit removal and servicing.

I. Install sample ports upstream and downstream of water softener system.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.4 IDENTIFICATION

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

3.5 FIELD QUALITY CONTROL

A. Testing Agency:
   1. 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 tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:
   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 unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Water softeners will be considered defective if they do not pass tests and inspections.

F. 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.

B. Add water to brine tanks and fill with the following form of salt:
1. Water Softeners: Processed, plain salt pellets.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
1. ASTM D859, "Test Method for Silica in Water."
2. ASTM D1067, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D1068, "Test Methods for Iron in Water."
4. ASTM D1126, "Test Method for Hardness in Water."
5. ASTM D1129, "Terminology Relating to Water."
6. ASTM D3370, "Practices for Sampling Water from Closed Conduits."

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of water softener Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper water softener operation at rated capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

3.8 DEMONSTRATION

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

END OF SECTION 22 31 00

SECTION 22 35 00 - DOMESTIC-WATER HEAT PUMP

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes:
   1. Water source heat pump water heaters for domestic hot water.

1.2 REFERENCES

A. ASME Boiler and Pressure vessel code

B. UL60335-1 HVACR Equipment

C. UL60335-2-40 HVACR Equipment

D. NSF-61 Potable water safety

E. NSF-372 Potable water safety

F. CSA C22.2 60335-1 HVACR Equipment

G. CSA 60335-2-40 (LC16116-1) HVACR Equipment

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties, SCCR ratings, source water operating range, power factor, shop drawings, and accessories for each model indicated.

B. Wiring Diagrams: Detail for wiring power signal, differentiate between manufacture- installed and field-installed wiring.

C. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include maintenance guide and wiring diagrams

1.4 REGULATORY REQUIREMENTS

A. Shall be certified to UL60335-1

B. Shall be certified to UL60335-2-40

C. Conform to ASME Section VIII for heat exchanger construction.

D. Shall be certified to NSF-61 for commercial domestic hot water.

E. Shall be certified to NSF-372 for commercial domestic hot water.

F. Shall be certified to CSA C22.2 60335

G. Shall be certified to CSA 6035-2-40 (LC16116-1)

1.5 COORDINATION

A. Coordinate size and location of concrete bases

B. Coordinate electrical infrastructure with electrician.

C. Coordinate BMS integration with building controls provider.

1.6 WARRANTY

A. Equipment shall include parts warranty for 12 months from startup or 18 months from shipment, whichever comes first

B. Compressors shall include a 5-year parts warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Nyle (Basis of Design)
2. WaterFurnace
3. Transom

2.2 WATER SOURCE HEAT PUMP (WSHP)

A. Heat pump water heater shall be packaged water source equipment, factory assembled, charged, and tested. The heat pump shall be suitable for heating domestic hot water and have the capability of producing no less than 160°F water at 35°F source water temperature, with published heating capacity and C.O.P. based on project specifications.

B. Heat Pump unit shall consist of:
1. Compressor
2. Condenser
3. Evaporator
4. Integral hot water circulating pump
5. Piping
6. Controls
7. Factory charged and tested.

C. All components, including assemblies, sub-assemblies and the materials that go into constructing the heat pump water heater's wetted circuit must be certified for coming in direct contact with domestic hot water, including but not limited to: piping, brazing, soldering or welding materials, circulator pump, flow sensor, temperature sensors, thread sealant, flow control valves and flat plate heat exchanger.

D. The heat pump water heater shall have an SCCR rating of not less than 100 kA.

E. Heat pump shall be compliant with Build America Buy America Act section 70912.6

F. WSHP Cabinet
1. Shall be corrosion resistant powder coated aluminum.
2. Compartments shall have large access doors for servicing.
3. Cabinet shall be designed for outdoor operation.
4. Cabinet shall be insulated to prevent condensation from forming on exterior surfaces.

G. WSHP Compressor & refrigeration

H. Compressor: Suitable for high temperature operation with R-513A refrigerant.

I. Compressor shall be furnished with service ports for suction and discharge connections

J. Compressor Controls: Compressor controls/accessories must include the following:
1. High Pressure Safety monitoring
2. Low Pressure Safety monitoring
3. Incoming power Phase Monitoring
4. Compressor manufacturer-recommended motor protection module
5. Anti-Short Cycle Control: Unit shall be factory controlled to prevent excessive short cycling.

K. Refrigerant Accessories:

L. Filter-Drier: Sweat connection type.

M. Site Glass: Moisture indicating type.

N. Liquid Line Service Valves: Bronze quarter turn type.

O. Discharge Check Valve: Copper magnetic in-line type.

P. Liquid Line Solenoid Valve: Electrically actuated.

Q. Compressor Crankcase Heater

R. Suction accumulator

S. Liquid receiver

T. Condenser
1. 316L Stainless steel copper brazed plate vented double wall type, standard on all units. Single wall condenser construction shall not be allowed. UL Listed, and suitable for up to 450°F (232°C) high temperature operation with domestic hot water. Unit shall be operational pressure rated to no less than 435 PSI (30 Bar).

U. Evaporator
1. 316L Stainless steel copper brazed plate vented single wall type, standard on all units. UL Listing is required. Unit shall be operational pressure rated to no less than 435 PSI (30 Bar).

V. Electronics
1. Shall be equipped with power and phase monitor capable of protecting the heat pump from 10% variances phase to phase, out of phase, reverse phase, high and low phase.

2.3 WATER CIRCULATING PUMPS

A. Shall be factory installed and wired in-line DHW circulator with lead-free bronze or stainless-steel body, and able to deliver the rated flow against the external head shown on the drawings.

2.4 CONTROLS:

A. Installed controls shall include:

B. PLC Controls

C. Panel Mount Control Touch Screen

D. Low Temperature Freeze/Flow Monitoring

E. Flow Meter

F. Data Logging at One Second Intervals

G. BMS Compatibility With Varied Protocol Options
1. Bacnet MSTP
2. Bacnet Ethernet
3. Modbus MSTP

H. Communications between units shall be inherent ethernet.

I. Units shall have dry contact external demand signal.

2.5 CONSTANT LEAVING WATER TEMPERATURE CONTROL (SINGLE-PASS ONLY)

A. Heat pump shall be factory equipped with an electronic temperature control valve which automatically maintains constant leaving water temperature. Leaving water temperature is set by the heat pump operator/user via the field adjustable touch screen interface.

2.6 FREEZE PROTECTION

A. Freeze Detection: Heat pump shall be factory equipped with water temperature detection indicating a freeze risk is present on both DHW and source loop sides.

B. Freeze Protection: Heat pump shall open valves and transmit a run signal to trigger attached valves or pumps and suspend compressor operation during a freeze protection event.

C. Glycol Systems: Heat pump shall allow for source loop glycol systems with adjustable freeze protection settings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water heaters level and plumb in accordance with manufacturer's written instructions and project documents

B. Install shall conform to jurisdictional codes, as well as all applicable state and national standards.

3.2 START-UP

A. Start up on the unit shall be performed by factory trained and authorized personnel

B. A copy of the startup report including all pertinent startup condition documentation will be provided to the owner and factory.

END OF SECTION 22 35 00

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SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wall-mounted water closets.
2. Flushometer valves.
3. Toilet seats.
4. Supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:
1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. Comply with ASME A112.6.1M for water-closet supports.
6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 WALL-MOUNTED WATER CLOSETS

A. Water Closets (WC-1) - Wall Mounted, Top Spud:
1. Basis of Design: Sloan Model SU-2459-STG. Available manufacturers offering products that may be incorporated into the Work are the following:
a. American Standard.
b. Gerber Plumbing Fixtures LLC.
c. Kohler Co.
d. ProFlo; a Ferguson Enterprises, Inc. brand.

e. TOTO USA, INC.
f. Zurn Industries, LLC.

2. Bowl:
   a. Material: Vitreous china.
   b. Type: Siphon jet.
   c. Style: Flushometer valve.
   d. Mounting Height: Standard.
   e. Rim Contour: Elongated.
   f. Water Consumption: 1.28 gal. per flush.
   g. Spud Size and Location: NPS 1-1/2; top.
   h. Color: White.
3. Support: Water-closet carrier.

B. Water Closets - (WC-2) - Wall Mounted, Top Spud:
1. Basis of Design: Sloan Model SU-2459-STG. Available manufacturers offering products that may be incorporated into the Work are the following:
   a. American Standard.
   b. Gerber Plumbing Fixtures LLC.
   c. Kohler Co.
   d. ProFlo; a Ferguson Enterprises, Inc. brand.
   e. Sloan Valve Company.
   f. TOTO USA, INC.
   g. Zurn Industries, LLC.
2. Bowl:
   a. Material: Vitreous china.
   b. Type: Siphon jet.
   c. Style: Flushometer valve.
   d. Mounting Height: ADA.
   e. Rim Contour: Elongated.
   f. Water Consumption: 1.28 gal. per flush.
   g. Spud Size and Location: NPS 1-1/2; top.
   h. Color: White.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm Type; Sensor Operated:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan Valve Company.
   b. Zurn Industries, LLC.
   c. American Standard.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Style: Exposed.
6. Flushometer-Valve Finish: Chrome-plated.
7. Handle Finish: Chrome-plated.

8. Consumption: 1.28 gal. per flush.
9. Minimum Inlet: NPS 1.
10. Minimum Outlet: NPS 1-1/4.
11. Power: Size AA Battery Operated Infrared Sensor
12. “Low Battery” Flashing LED
13. Courtesy Flush Override Button

2.4 TOILET SEATS

A. Toilet Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard.
      b. Bemis Manufacturing Company.
      c. Church Seats; Bemis Manufacturing Company.
      d. Kohler Co.
      e. Zurn Industries, LLC.
   2. Material: Plastic.
   3. Type: Commercial (Heavy duty).
   4. Shape: Elongated rim, open front.
   5. Hinge: Check.
   6. Hinge Material: Non-corroding metal.
   7. Seat Cover: Not required.
   8. Color: White.
   9. Surface Treatment: Antimicrobial.

2.5 SUPPORTS

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

      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. MIFAB, Inc.
      c. WATTS; A Watts Water Technologies Company.
      d. Wade; a subsidiary of McWane Inc.
      e. Zurn Industries, LLC.
      f. Josam Company.
   2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space. Carriers are to be floor mounted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping 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, GENERAL

A. Water-Closet Installation:
   1. Install level and plumb.
   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 in accordance with ICC 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.
   5. Measure support height installation from finished floor, not structural floor.

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 actuators in locations easily reachable for people with disabilities.

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 PIPING 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.

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 13.13

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SECTION 22 42 13.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wall-hung urinals.
2. Urinal flushometer valves.
3. Supports.

B. Related Requirements:
1. Section 224600 "Security Plumbing Fixtures" for security urinals.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals (UR-1) - Wall Hung, Top Outlet, Siphon Jet:
1. Basis of Design: Sloan Model SU-1009-STG: Available manufacturers offering products that may be incorporated into the Work are the following:
a. American Standard.
b. Crane
c. Kohler.
2. Fixture:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
b. Material: Vitreous china.
c. Type: Siphon jet.
d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
e. Water Consumption: 0.5 gpf.
f. Spud Size and Location: NPS 3/4; top.
g. Outlet Size and Location: NPS 2; back.
h. Color: White.
3. Waste Fitting:
a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.

4. Support: Type I urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights**.**
5. Urinal Mounting Height: Standard.

2.2 URINAL FLUSHOMETER VALVES

A. Flushometer Valves:
1. Basis of Design: Sloan Model G 8186-1.0: Available manufacturers offering products that may be incorporated into the Work are the following:
   a. American Standard.
   b. Kohler.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
3. Valve Operating Pressure: 15-80 psi.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Power Type: Battery Operated, Size AA
10. Consumption: 0.5 gal. per flush.
11. Minimum Inlet: NPS 3/4.
12. Minimum Outlet: NPS 1-1/4.
13. Courtesy Flush Override Button
14. “Low Battery” Flashing LED

2.3 SUPPORTS

A. Type I Urinal Carrier:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Josam Company.
   c. MIFAB, Inc.
   d. WATTS; A Watts Water Technologies Company.
   e. Wade; a subsidiary of McWane Inc.
   f. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Urinal Installation:
1. Install urinals level and plumb according to rough-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 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 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."

3.2 PIPING 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.

3.3 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.

3.4 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 13.16

SECTION 22 42 16.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Vitreous-china, counter-mounted lavatories.
2. Vitreous-china, wall-mounted lavatories.
3. Integrated Sink System, wall-mounted.
4. Automatically operated lavatory faucets.
5. Automatic Hand Dryers
6. Automatic Soap Dispenser
7. Supply fittings.
8. Waste fittings.
9. Lavatory supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 WALL MOUNTED LAVATORIES

A. Lavatory (LAV-1) – Solid Surface Countertop with Undermount Lavatory, Wall mounted:
1. Basis of Design: DuPont Corian Solid Surface Countertop with Integral Undermount Lavatory and Offset Drain. Available manufacturers offering products that may be incorporated into the Work are the following:
a. Corian Design: DuPont.
b. American Standard.
c. Briggs Plumbing Products, Inc.
d. Gerber Plumbing Fixtures LLC.
e. Kohler Co.
f. Mansfield Plumbing Products LLC.

g. ProFlo; a Ferguson Enterprises, Inc. brand.
h. TOTO USA, INC.

2. Countertop:
   a. Material: Solid surface acrylic polymer.
   b. Color: White.
   c. Configuration: Wall-mounted countertop.
   d. Sink Type: Integral undermount lavatory.
   e. Drain Location: Offset drain.
   f. ADA Compliant.
   g. Provide concealed steel support brackets as required.
   h. Provide backsplash where indicated on drawings.
3. Fixture:
   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: Undermount
   c. Faucet-Hole Punching: One hole.
   d. Faucet-Hole Location: Top.
   e. Deck Mounted Dryer with HEPA Filter Technology
   f. Deck Mounted Soap Dispenser
   g. ADA Compliant
   h. Color: Selected by Architect.

2.2 AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Lavatory Faucets - Automatic Type: Hardwired Electronic Sensor Operated, Sensor operated:
   1. Basis of Design: American Standard Selectronic Integrated Faucet, Model 705B.205. Available manufacturers offering products that may be incorporated into the Work are the following:
      a. American Standard.
      b. Bradley Corporation.
      c. Chicago Faucets; Geberit Group.
      d. Gerber Plumbing Fixtures LLC.
      e. Kohler Co.
      f. Speakman Company.
   2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
   3. 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.

4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Temperature Mixer: Remote thermostatic mixing valve.
9. Trim Plate: 4 inches
10. Maximum Flow Rate: 0.5 gpm.
11. Mounting Type: Deck, concealed.
12. Spout rigid type.
13. Spray Outlet: Multi Laminar.
14. Sensor Type: Infrared
15. ADA Compliant
16. Power Supply: Hardwired, 120V/24V transformer system as required by manufacturer.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:
1. NPS 3/8.
2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces] riser.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
b. Stainless steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless steel tube to wall; and stainless steel wall flange.

2.5 LAVATORY SUPPORTS

A. Lavatory Carrier:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. WATTS; A Watts Water Technologies Company.
e. Wade; a subsidiary of McWane Inc.
f. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lavatories level and plumb in accordance with roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.

D. 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."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.2 PIPING 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."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.13

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SECTION 22 42 16.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Kitchen/utility sinks.
2. Mop Sinks.
3. Supply fittings.
4. Waste fittings.
5. Sink supports.
6. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 KITCHEN SINK (S-1)

A. Kitchen Sinks - Stainless Steel, Counter Mounted:
1. Basis of Design: American Standard Edgewater series: Available manufacturers offering products that may be incorporated into the Work are the following:
a. American Standard
b. Advance Tabco.
c. Amerisink Inc.
d. Eagle Group.
e. Franke.
f. Krowne.
2. Fixture:
a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back.
c. Number of Compartments: One.
d. Overall Dimensions: 17 x 20 inches.
e. Material: 18-gauge, Type 304 stainless steel.
f. Compartment:
1) Dimensions: 17 x 20 x 7-5/8 inches.

2) Drain: Grid with NPS 1-1/2 tailpiece and twist drain.
3) Drain Location: Centered in compartment.
4) Depth: Standard.

3. Faucet(s): Refer to Plumbing Fixture Schedule on Drawing P621
4. Supply Fittings:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
      1) Operation: Loose key.
      2) Risers: NPS 1/2, chrome-plated, rigid-copper pipe.
5. Waste Fittings:
   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):
      1) Size: NPS 1-1/2.
      2) Material:
         a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.
         b) Stainless steel, two-piece trap and swivel elbow with 0.012 inch thick stainless steel tube to wall; and stainless steel wall flange.
   c. Continuous Waste:
      1) Size: NPS 1-1/2.
      2) Material: Chrome-plated, 17-gauge brass tube.
6. Mounting: On counter with sealant.

2.2 MOP SINK MS-1

A. Mop Sink – Terrazzo-Ware:
   1. Basis of Design: Fiat Molded Stone Mop Basin: Available manufacturers offering products that may be incorporated into the Work are the following:
      a. Fiat.
      b. Crane.
      c. Stern Williams.
      d. Zurn.
   2. Fixture:
      a. Integral center drain with removable stainless steel grid strainer.
      b. Front shoulder dropped 6 inches.
      c. Corner with rounded front
      d. Overall Dimensions: 28x28x12 inches.
      e. Material: Terrazo.
      f. Mop Hanger
      g. Rubber drain gaskets
      h. Drain: Grid with NPS 3 outlet.
      i. Color: From manufacturer's standard color selection.
   3. Faucet(s): Refer to Plumbing Fixture Schedule on Drawing P621

a. Faucet: Chrome-plated utility faucet with manual hot water and cold water handles. Ship loose for field installation.

2.3 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/2.
2. Material:
a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall]; and chrome-plated brass or steel wall flange.

2.4 GROUT

A. Standard: ASTM C1107/C1107M, 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 INSTALLATION

A. Install sinks level and plumb in accordance with rough-in drawings.

B. Set floor-mounted sinks in leveling bed of cement grout.

C. Install water-supply piping with stop on each supply to each sink faucet.
1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

D. 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."

E. Seal joints between sinks and 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."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.2 PIPING 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."

3.3 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.4 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.16

SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Eyewash equipment.
   2. Combination units.
   3. Water-tempering equipment.

1.2 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. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between 60 and 100 deg F.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:
   1. Plans, elevations, sections, and mounting details.
   2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

G. 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 EYEWASH EQUIPMENT

A. Eyewash Units - Accessible, Wall Mounted, Plumbed: (EW-1)
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Guardian
b. Bradley Corporation.
c. Speakman Company.
d. Stingray Systems LLC.
2. Source Limitations: Obtain eyewash units, accessible, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two receptor-mounted spray heads.
7. Receptor: Stainless steel bowl.
8. Drain Piping:
a. Size: NPS 1-1/4 minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.
9. Mounting: Wall bracket.
10. Accessories:
a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
c. Flow switch; single pole.

d. Dust covers.
e. Scald protection valve.

2.3 COMBINATION UNITS

A. Combination Units - Emergency Shower with Eyewash, Accessible, Plumbed: (EWS-1)
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Bradley Corporation.
b. Encon Safety Products.
c. Guardian Equipment Co.
d. Acorn Safety; a Division of Morris Group International.
2. Source Limitations: Obtain combination units, emergency shower with eyewash, accessible, plumbed, from single manufacturer.
3. Piping:
a. Material: Galvanized steel.
b. Unit Supply: NPS 1-1/4 minimum.
c. Unit Drain: Outlet at back or side near bottom.
4. Shower:
a. Capacity: Not less than 20 gpm for at least 15 minutes.
b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Pull rod.
d. Shower Head: 8-inch- minimum diameter, plastic.
e. Mounting: Pedestal.
5. Eyewash Unit:
a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: stainless steel bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eyewash unit.
1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.
6. Accessories:
a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
c. Flow switch; single pole.
d. Combination Flashing Light and Alarm horn.
e. Magnetically actuated proximity switch.
f. 60-inch pull rod.

2.4 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong International, Inc.
      b. Bradley Corporation.
      c. Guardian Equipment Co.
      d. WATTS; A Watts Water Technologies Company.
   2. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
   3. Description: Factory-fabricated equipment with thermostatic mixing valve.
      a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
      b. Supply Connections: For hot and cold water.

2.5 EMERGENCY FIXTURE ALARM SYSTEMS

A. Emergency Fixture Audible/Visual Alarm:
   1. Basis of Design: Guardian Equipment Model AP275-200.
   2. Available Manufacturers:
      a. Guardian Equipment.
      b. Bradley Corporation.
      c. Speakman Company.
      d. Acorn Safety.
   3. Description:
      a. Factory-assembled alarm package for emergency eyewash and emergency shower fixtures.
      b. Audible horn and flashing visual beacon.
      c. Activation automatically initiated upon operation of emergency fixture.
      d. Suitable for indoor installation.
      e. NEMA-rated enclosure appropriate for installation location.
   4. Electrical Characteristics:
      a. 120 VAC power supply.
      b. Hardwired connection.
      c. Coordinate power requirements with Division 26.
   5. Activation Devices:
      a. Flow switch for eyewash and shower operation detection.
      b. Magnetically actuated proximity switch where required by manufacturer.
      c. Switches furnished and factory coordinated by alarm manufacturer.
   6. Performance:
      a. Audible alarm and visual strobe shall activate immediately upon operation of emergency fixture.
      b. Alarm shall remain active until fixture is shut off.
      c. Alarm shall automatically reset after fixture operation ceases.
   7. Accessories:

a. Mounting hardware.
b. Factory wiring between alarm and activation devices.
c. Transformer as required.

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 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

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, to facilitate maintenance of equipment. 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 "General-Duty Valves for Plumbing Piping." Emergency fixture isolation valves shall be lockable in the open position.
1. Exceptions:
a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
b. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. 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."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. 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."

H. 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."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

J. Fill self-contained fixtures with flushing fluid.

3.3 PIPING 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 Heating 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 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

E. Provide dedicated branch circuit for alarm system where required by manufacturer.

3.5 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."

3.6 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.
   5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.8 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

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

END OF SECTION 22 45 00

SECTION 22 47 00 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water coolers.
   2. Fixture carriers.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings:
   1. Plans, elevations, sections, and mounting and attachment details.
   2. Details of fixture assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Diagrams for power wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 WARRANTY

A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace water coolers that fail in materials or workmanship within specified warranty period.

B. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:
   1. Water coolers, intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the authority having jurisdiction, and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 WATER COOLERS

A. Water Coolers - Surface Wall Mounted:

1. Basis of Design: Elkay Model LZSTL8WSBPRO Bi-Level ADA Cooler with integral bottle filling station: Available manufacturers offering products that may be incorporated into the Work are the following:
    a. Elkay
    b. Murdock Manufacturing; A Division of Morris Group International.
    c. Halsey Taylor
    d. Oasis International.
2. Source Limitations: Obtain surface wall-mounted, powder-coated-metal, water coolers from single source from single manufacturer.
3. Standards:
    a. NSF 61.
    b. NSF 372.
    c. ASHRAE 18.
    d. UL 399.
    e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Color: Gray.
5. Bubbler: Flexi-Guard Safety type.
6. Control: Push bar.
7. Bottle filling station. Sensor activated, hands free operation with laminar flow discharge, antimicrobial components, visual bottle counter, and automatic filter status monitoring.
8. Drain: Grid with NPS 1-1/4 tailpiece.
9. Supply: NPS 3/8 with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.
    a. Standards:
        1) NSF 42.
        2) NSF 53.
12. Bottle filling station features:
    a. Hands free infrared sensor activation.
    b. Visual display indicating number of plastic bottles saved.
    c. Automatic filter monitoring system with visual indication of filter status.
    d. Laminar flow water delivery.
    e. Antimicrobial-treated key plastic components.
    f. Rated flow as recommended by manufacturer for bottle filling operation.
13. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
14. Support: Fixture carrier.
15. Water-Cooler Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.
16. Capacities and Characteristics:
    a. Cooled Water: 8 gph.
    b. Ambient-Air Temperature: 90 deg F.
    c. Inlet-Water Temperature: 80 deg F.

d. Cooled-Water Temperature: 50 deg F.
e. Electrical Characteristics:
    1) Volts: 120 V ac.
    2) Phase: Single.
    3) Hertz: 60 Hz.
    4) Full-Load Amperes: 5 A.

2.3 FIXTURE CARRIERS

A. Fixture Carriers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. Josam Company.
    c. MIFAB, Inc.
    d. WATTS; A Watts Water Technologies Company.
    e. Wade; a subsidiary of McWane Inc.
    f. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

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

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

3.2 INSTALLATION

A. Install fixtures level and plumb in accordance with roughing-in drawings. Install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball 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."

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

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING 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 shutoff valve on water supply to each fixture. Install valve upstream from filter for drinking fountain, water cooler, and bottle filling station. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturers, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

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

3.6 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, in accordance with 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 00

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SECTION 23 01 30.52 - EXISTING HVAC AIR DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.

1.2 DEFINITIONS

A. ACAC: American Council for Accredited Certification.

B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program

C. ASCS: Air systems cleaning specialist.

D. CESB: Council of Engineering and Scientific Specialty Boards.

E. CMI: Certified Microbial Investigator.

F. CMC: Certified Microbial Consultant.

G. CMR: Certified Microbial Remediator.

H. CMRS: Certified Microbial Remediation Supervisor.

I. EMLAP: Environmental Microbiology Laboratory Accreditation Program.

J. IEP: Indoor Environmental Professional.

K. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.

L. NADCA: National Air Duct Cleaners Association.

M. NADCA ACR: National Air Duct Cleaners Association’s Assessment, Cleaning and Restoration of HVAC Systems

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HVAC CLEANING AGENTS

A. Description:
1. Formulated for each specific soiled coil condition that needs remedy.

2.2 ANTIMICROBIAL SURFACE TREATMENT

A. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.
1. Formulated to kill and inhibit growth of microorganisms.
2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
3. Have no residual action after drying, with zero VOC off-gassing.
4. OSHA compliant.
5. Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures.

C. Proceed with work only after conditions detrimental to performance of the Work have been corrected and cleaning plan has been approved.

D. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

E. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

A. Comply with NADCA ACR.

B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.

C. Remove non-adhered substances and deposits from within the HVAC system.

D. Systems and Components to Be Cleaned: All air-moving and -distribution equipment identified to be cleaned in the design drawings.

E. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
   1. Particulate Collection: For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
   2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

F. Control odors and mist vapors during the cleaning and restoration process.

G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

I. Clean all air-distribution devices, registers, grilles, and diffusers.

J. Clean non-adhered substance deposits according to NADCA ACR and the following:
   1. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
   2. Clean reheat coils, and other airstream components.

K. Air-Distribution Systems:
   1. Create service openings in the HVAC system as necessary to accommodate cleaning.
   2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).

L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

M. Mechanical Cleaning Methodology:
   1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
      a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.

b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.

2. Cleaning Mineral-Fiber Insulation Components:
   a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
   b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
   c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:
   1. See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.
   2. Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
   3. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.
   4. Rinse thoroughly with clean water to remove any latent residues.

3.3 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

B. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

C. Verification of Coil Cleaning: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

D. Prepare a written cleanliness verification report.

3.4 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 "Metal Ducts"

C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts"

D. Replace damaged insulation according to Section 230713 "Duct Insulation."

E. Ensure that closures do not hinder or alter airflow.

F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

G. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.

END OF SECTION 23 01 30.52

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SECTION 23 05 00 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 CONDITIONS

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

1.2 WORK INCLUDE: The work of this Contract shall include and provide for all labor, tools, materials necessary for installation and for proper operation even though not specifically mentioned or indicated on plans, but which are usually provided or essential for proper operation of the system.

A. Hydronic and Cold Condensate Piping Work

B. Duct Work

C. Ventilating Work.

D. Insulation Work.

E. Temperature Controls Work.

F. Testing and Balancing.

G. Air Conditioning and Heating Work.

1.3 LAWS, PERMITS AND INSPECTIONS

A. Comply with all Federal, State, County, Municipal, NFPA, NBFU, AGA, UL, and Utility Co. Laws, ordinances and regulations that cover the work.

B. Conform to any local codes.

C. Apply for and obtain all required permits and inspections.

D. Pay all fees.

E. Furnish all certificates of approval.

1.4 STANDARDS OF WORKMANSHIP

A. All work shall be executed in accord with recognized standards of workmanship. All work shall be installed in a neat and orderly manner. If, in the judgment of the Engineer, the workmanship is not acceptable, the work in question is to be removed and reinstalled in a manner satisfactory to the Engineer.

B. Unless specifically noted otherwise no building structural members including beams, columns, load bearing walls, etc. shall be cut, drilled or modified in any way for the installation of any HVAC equipment without written approval of the Structural Engineer.

C. Contractor's Responsibility:
   1. The Contractor shall be responsible for establishing grades and elevations, and checking of all interferences, and shall verify all dimensions and locations in the field for work specified in the HVAC sections of these specifications.

1.5 REVIEW OF MATERIALS

A. Materials:
   1. Equipment or material of same type or classification, used for the same purpose, shall be products of the same manufacturer. All material shall be new and of the latest design of manufacturer providing equipment or materials. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ASME, or other applicable technical standards, suitable for maximum working pressure and shall have neat and finished appearance.

B. Contractor is responsible for all information submitted in shop drawings for review. Contractor shall review all shop drawing submittals for full compliance with construction documents prior to forwarding to the Architect/Engineer for review. All products, options and accessories noted in the specification shall be highlighted in the corresponding submittals by the supplier or contractor noting compliance prior to submitting for review. Manufacture specific deviances shall also be noted. The absence of information on shop drawings, which may have not been noted for correction during the Architect/Engineer Review, shall be brought to the attention of the above by the contractor for any additional coordination prior to release of submittals for manufacture and shipment. Required revisions and modifications to work from uncoordinated submittals will be at the expense of the installing contractor. Also, any options missing in the submittal and not corrected will presumably be an acceptable field modification (The contractor must provide the specified option at his own cost). Shop drawings will be submitted according to Section 01 33 00.

C. Shop Drawings: In accord with the time limits and requirements of Div. 1, this Contractor is to submit all shop drawings to the Architect with evidence of checking by Contractor.

D. Samples: If requested by the Architect or Engineer, this Contractor shall submit samples of materials for their review. Upon approval, the samples are to be removed from the Architect's office and stored at the project until such time as the project is completed or the Architect or Engineer has given written permission for the samples to be removed from the site. At the completion of the project, all samples are to be delivered in good condition to the Owner.

E. Shop drawings shall be checked by the Contractor prior to submission, and stamped with the words "Checked for Compliance".

1.6 PAINTING

A. Paint all hangers and exposed or unpainted or un-galvanized iron work in the Heating, Ventilation and Air Conditioning Systems with two brush coats of Black Rust-Oleum paint or as required by division 7 specifications.

B. Touch up any damaged surfaces on factory painted equipment.

C. Surfaces seen through grilles and registers: 2 coats flat black paint.

1.7 MINOR DEVIATIONS

A. Plans: The plans are in part diagrammatic and are not to be construed as relieving this Contractor from on-site coordination between the work of this Contract and the work of other Contractors.

1.8 ELECTRICAL

A. It shall be the responsibility of the Contractor to insure that the voltage and current characteristics of the electrical equipment furnished by him shall be suitable for the electrical services as specified or indicated. If the electrical requirements change for a substitution, the Contractor must bear all increased costs associated with the substitution modification.

B. The Contractor is responsible for wiring as shown on the Electrical Drawings. The Contractor is responsible for all devices, circuits, raceways, conductors, interlocks and appurtenances shown or required for proper operation of the work of this contract including all DDC work. The extent of work (labor and materials) and the required cost to complete the equipment installation shall be included in the bid.

C. All single phase motors shall have a minimum service factor of 1.35, three phase motors shall have a 1.15 service factor. All single phase motors shall be provided with integral thermal overload protection.

D. All motors shall meet or exceed the New York State Energy Code requirements. Motors 1 HP and larger shall be premium efficiency.

1.9 INSPECTIONS

A. The undertaking of job inspections by Architect or Engineer shall not be construed as supervision of actual construction, nor make them responsible for providing a safe place for performance of work by Contractors or Contractors' employees or those of suppliers of Contractors, or for access, visits, use, work, travel, or occupancy by any person.

1.10 PROTECTIVE COVERING

A. Properly protect in an approved manner, all finished surfaces of equipment against all damage from plaster, paint, scratching denting, etc., until all other trades have completed their work. Protect all openings to prevent entry of debris.

1.11 PROTECTION FROM FREEZING

A. During construction and until final acceptance, protect from freezing all fixtures, equipment and piping, both in building, trenches, etc. Any damage shall be repaired or replaced at Contractor's expense to meet Architect's approval.

1.12 STANDARDS

A. All ductwork to be in accordance with SMACNA standards.

B. All filters to be ARI rated.

C. All fans to be AMCA capacity and sound power rated.

D. All Electrical equipment to be UL listed.

E. All terminal air delivery devices to be ADC rated.

F. Conform to ANSI B31.5 and ANSI B31.9 Codes for pressure piping and refrigerant piping.

1.13 ACCESS DOORS

A. Unless otherwise specified, the contractor shall provide access panels for concealed valves, expansion joints, valves, traps, strainers, dampers, and other parts requiring accessibility for operation and maintenance and shall install all access panels in drywall or masonry construction. Access panels generally are not shown on drawings to allow for installation flexibility.

B. Provide where indicated and where required for access to all equipment. Size 16" x 24" unless otherwise noted. It is to be noted that various type frames are required for specific wall and ceiling finishes. Any door having an area exceeding 324 square inches shall have 2 cam locks.

1.14 NOISE AND VIBRATION

A. Mechanical and electrical equipment shall operate without noise and vibration as determined by Architect. Maximum sound level in occupied spaces shall be RC-35.

B. If noise or vibration is transmitted to occupied portions of the building by equipment, piping, ducts, etc., make necessary changes and additions, as approved at no expense to the Owner.

1.15 CUTTING AND PATCHING

A. This Contractor shall do all cutting and patching necessary for inclusion of his work.

B. Any modifications, attachments, etc., to roof must be completed only after the roof bonding agent has been notified and appropriate installation details given.

1.16 JOB SUPERVISION

A. Furnish at site during construction a competent and experienced foreman. He shall have complete charge of all field work of this Contract. He shall be authorized to act for the Contractor in his absence, and to accept instructions from the Architect or Engineer.

1.17 EQUIPMENT IDENTIFICATION

A. Equipment to be labeled to include all installed as a part of this contract including but not limited to condensing units.

B. Identification markers shall be 2-1/4" x 4-1/2" for all equipment.

C. Markers shall be stick-on type as manufactured by Seton Nameplate Co. or Westline Products.

1.18 EQUIPMENT ARRANGEMENTS

A. Because all equipment of equal capacity is not necessarily of same arrangements, size of construction, the plans are prepared on basis of one manufacturer's equipment, even though all other manufacturer's names are mentioned and contractor elects to use some of their equipment which differs in arrangements, size, etc., he does so subject to following conditions:
   1. If requested by Engineers, submit in each case, a sketch to scale, indicating installation proposed equipment, showing maintenance and service space.
   2. If revised arrangements meet approval:
      a. Make all incidental changes in piping, ductwork, supports, insulation, etc.
      b. Provide any additional motors, controllers, valves, fittings and other additional equipment required for proper operation of system resulting from the selection of equipment.
      c. Include all changes in general construction necessitated by this equipment.
      d. The contractor is responsible for proper location of roughing and connections.
      e. Make such changes at no increase in contract price.
   3. If revised arrangement does not meet approval because of increase in static, possibility of increase in noise, lack of space or headroom, insufficient clearance for removal of parts, or any reason then provide equipment which conforms to contract drawings.

1.19 ADJUSTMENT AND LUBRICATION

A. Includes:

1. Verification that all motors are in proper rotation.
2. Verification that all dampers are closed tightly.
3. Verification that all electrical work is free from incorrect grounds.
4. Verification that all piping systems are air free and of proper pressure and refrigerant systems are appropriately cleaned, purged and charged.

B. As soon as installed, lubricate and leave in good working order, all motors, bearings, etc., in accordance with manufacturer's instructions.

C. Provide 8-1/2" x 11" lubrication chart, type in capital letters, mounted in wood frame under clear plastic. Hang where indicated. Contractor to provide chart listing all motors.

D. List following information:
1. Name and location of equipment.
2. Type of lubrication recommended by manufacturer.
3. Lubrication period recommended by manufacturer.

1.20 PROJECT CLOSE-OUT

A. Provide the following as a requirement for project close-out. Included, but not limited to, are the following:
1. Operation and Maintenance Manuals (Instruction Portfolios).
2. Project Record Drawings (As-builts) including wiring and piping diagrams.
3. Lubrication/Valve Charts.
4. Testing & Balancing Reports.
5. Letter of Automatic Temperature Control Work Completion.
6. Completed Commissioning Reports
7. Equipment Warranties
8. Asset and Serial Numbers of equipment
9. Training Documentation
10. Record Drawings
11. Refer to Division I for additional requirements.

1.21 DEMONSTRATION OF COMPLETE MECHANICAL SYSTEMS

A. Work Included:
1. Thoroughly demonstrate and instruct designated representatives of the Owner in the care and operation of all the heating, ventilating, and air conditioning systems and equipment furnished and installed as a part of this contract.
2. Manufacturers of certain equipment specified herein shall provide technically qualified factory representatives to train the Owner's representative in the care, maintenance, and operation of their product. This instruction and service of the factory representative shall be furnished as specified elsewhere in the specifications. This time is in addition to what is specified above and will not be counted as part of the contractor's instructions.
3. The time and place of all training shall be coordinated and scheduled by the Architect at the convenience of the Owner.

a. Submit letters attesting to the satisfactory completion of all instructions. Letters shall include date of completion of instruction, names of persons in attendance and be countersigned by authorized representative of Owner. Those signing the letter shall indicate that they have received and understand the training.
b. Following equipment and systems included:
   1) Dedicated Outside Air Units (DOAS)
   2) Air Handling Units (AHUs)
   3) Active Chilled Beams (ACB)
   4) Energy Recovery Ventilators (ERV)
   5) Rooftop Air Conditioners (RTU)
   6) Exhaust Fans (EF)
   7) Building Management System (BMS)
   8) Direct Digital Controls (DDC)
   9) Pumps
   10) Split System
c. Contractor shall include the training letters in the O & M Manuals.

PART 2 – PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 SHOP DRAWINGS/SUBMITTALS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings and submittals on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and submittals shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections.

B. Shop Drawings and submittals shall be dated and contain the following information. Incomplete submittals will not be accepted.
   1. Number each submittal.
   2. Name of project.
   3. Name of professional.
   4. Name of contractor.
   5. Description or names of equipment, materials and items. Complete identification of locations at which materials or equipment are to be installed.

C. All products specified in an individual Division 23 section shall be submitted at the same time.

D. Indicate deviations from contract requirements on the Letter of Transmittal.

E. Corrections or comments made on the Shop Drawings and/or submittals during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

3.2 COORDINATION DRAWINGS

A. Before construction work commences, the Contractor shall submit Coordination Drawings in the form of reproducible transparencies drawn at not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as Follows:

1. The Contractor will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be sepias of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.
2. The Contractor will provide sepia transparencies and/or prints and submit the base plan to all major trades' Contractors.
3. The Contractor will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.
4. Do not install equipment, equipment foundations or piping until Coordination drawings have been approved.

3.3 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workmen and site visitors.

3.4 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building. Perform first seasons winterizing in presence of Owner's operating staff.

3.5 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owner’s representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.
   1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

   2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any “rough ins” that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the contractor at no expense to the Owner.

   3. For equipment and connections provided in this contract, prepare roughing drawings as follows:
      a. New equipment: Obtain equipment roughing drawings and dimensions then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.6 CUTTING AND PATCHING

A. The Division 23 contract shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.7 CONCEALMENT

A. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.8 ACCESS DOORS AND PANELS

A. Install access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, valves, dampers, and other HVAC equipment requiring access for maintenance or operation.

B. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.9 FIRE-STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:
1. Refer to section 07 84 13 – “Penetration Firestopping.”

B. Refer to Architects ‘G-00X’ series Code Compliance drawings for locations of fire rated walls.

C. Duct, piping and other mechanical elements penetrating these walls need fire stopping provided around the penetration.

3.10 FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Contractor to be qualified and licensed by the Roofing manufacturer, as part of contract. Provide non-ferrous flashing pieces, skirts, hoods and collars as required to make pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by the contractor unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Apply all flashing and sealers within the temperature and humidity limits permitted by the manufacturer

3.11 UTILITY COMPANY SERVICES

A. Make arrangements with the utility company for renovation to the natural gas service to the Owner's distribution equipment. Provide underground gas service as called for and all pads, valves, meter, regulator and concrete bollards as required by the Utility Company. Coordinate all activities between the Owner and the Utility Company. The installation of the gas service shall comply with the published Utility Company standards. PAY ALL UTILITY COMPANY CHARGES. INCLUDE CHARGES IN THE BASE BID.

3.12 ALL TRADES TEMPORARY HEAT

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

3.13 TEMPORARY FACILITIES

A. Refer to the standard General Conditions of the contract for Construction and Supplemental General Conditions.
   1. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping.
   2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
   3. Temporary equipment and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open duct or piping remaining pressurized.

3.14 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

3.15 HVAC EQUIPMENT CONNECTIONS

A. Provide complete duct and piping connections to all HVAC equipment. Provide control connections to equipment where indicated on the drawings. Provide valves on piping ahead of each piece of equipment.

B. Provide all piping, control, accessories and connections as required for proper operation of Equipment provided by this contract and Owner-Furnished Equipment.

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.16 HVAC INSTALLATIONS

A. All installations shall comply with the following requirements:
   1. Coordinate HVAC systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
   2. The Architect shall control the placement of wall and ceiling mounted HVAC equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

3. Verify all dimensions with field measurements.
4. Arrange for all chases, slots and openings in other building components that are not indicated on drawings to allow for HVAC installations.
5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work schedules so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.
7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
9. Store Materials on dry base, at least 6-inches above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the Owners representative.
12. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.
13. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
14. No HVAC equipment shall be hidden or covered up prior to inspection by the Owners representative. All work that is determined to be unsatisfactory shall be corrected immediately.
15. All HVAC work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
16. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building unless specifically indicated otherwise on contract documents. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

17. Install access panels or doors where units are concealed behind finished surfaces.

3.17 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e. variable frequency drive and air handling unit) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 1 Sections for additional requirements.

3.18 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as- built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items. Bind above items in a three-ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance.

3.19 RECORD DOCUMENTS

A. Prepare and provide record documents in accordance with Division 1 Sections. In addition to those requirements provide the following:
   1. Utilities below floors, slabs and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.
   2. Take dimensions from a given fixed bench mark, such as the corner of a building, and neatly and clearly indicate same on reproducible prints.
   3. Provide Record Drawings for all Contract Work.
   4. Submit reproducible tracings, with all required corrections and submit complete set of final approved record drawings in PDF file format on CD.

5. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

B. Provide record documents electronically on a compact disk (CD), DVD or flash drive to the Owner. Also provide one (1) set of prints to the Owner.

END OF SECTION 23 05 00

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SECTION 23 05 04 - ELECTRIC WIRING - GEOTHERMAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services for the complete installation of motor control wiring and temperature control wiring as required in Contract Documents. Provide wiring and conduit, required to connect devices furnished as part of or adjunctive to the automatic temperature control system and for motor control regardless of the source of supply. Control wiring includes 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 120 volt maximum. Provide wiring in accordance with requirements specified in Division 26, "Electrical" and the National Electrical Code. Provide devices required for proper system operation, including special electrical switches, transformers, disconnect switches, relays, and circuit breaker protection.

B. Coordinate all work with Division 26, "Electrical".

1.2 WORK NOT INCLUDED

A. Power wiring for motors, motor starters and associated starting and control equipment, as well as the motor starters (except in the case of equipment specified to have packaged control/starters), are included in Division 26, "Electrical", unless otherwise called for.

1.3 QUALIFICATIONS

A. Wiring shall be installed in compliance with all requirements of Division 26, "Electrical".

1.4 SUBMITTALS

A. Provide complete wiring diagrams for equipment systems. Deliver wiring diagrams to proper trades in time for roughing of conduit, equipment connections, and avoid delay in construction schedule. Wiring diagrams and roughing information to be wired as part of the Work of Division 26, "Electrical", shall be clearly indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Refer to Division 26 specifications for required wiring materials.

PART 3 - EXECUTION

3.1 GENERAL

A. Check electrical wiring pertaining to equipment for completeness and correctness of connections.

Correct any misapplied motor and/or motor starter, improper thermal overload device, or device which fails to function and resultant damage, whether due to incorrect connections or improper information on wiring diagrams.

3.2 WIRING FOR CONTROL SYSTEMS

A. Provide motor control and temperature control wiring for equipment. All wiring shall be in conduit, unless otherwise noted below, supported on 5ft. centers. Refer to Section 260501 for type of conduit to be used in specific applications.

1. Provide 18 in. length flexible conduit at motors and devices subject to vibration.

2. Do not attach directly to hot surfaces, piping, or ductwork.

3. Control wiring shall be in separate conduit from all other wiring.

4. All control wiring within mechanical rooms shall be run in conduit.

5. Where allowable by Code and contract documents, temperature control wiring may be installed without conduit. Installation and wire insulation types shall be as described by NEC, Article 725. All low voltage wiring circuits 50 volt and under shall:

a. Have the proper insulation and meet the requirements of NEC Article 300-22 when installed in plenums or other spaces used for environmental air.

b. Be adequately supported using bridle rings spaced a maximum of 3 ft. on centers or other approved method when installed horizontally above accessible ceilings or run exposed in unfinished areas.

c. Be run in wall cavity or surface metal raceway where no access is available to wall cavity, in finished areas.

d. Be installed in conduit when installed vertically in Mechanical/Utility Rooms from panels and devices up to above ceiling, or 10 ft. above finished floor if no ceiling, then run exposed.

e. Be installed in conduit in all cases not specifically covered by the above cases, or where subject to physical damage.

B. Provide pushbutton stations, pilot lights, selector switches, auxiliary starter contacts, and other devices required to provide specified functions.

1. Provide green grounding wire circuited from starter, and run ground wire through conduit to each remote auxiliary relay, pushbutton station, remote panel heating device, thermostat, or device with potentials in excess of 50 volts. Size ground wire as required by NEC.

3.3 EQUIPMENT WIRING

A. Provide power and control wiring between sections of electrical radiation units, between shipping splits, and between remote panels, thermostats, disconnect switches, and their respective units. Provide control wiring from the package control system, to each respective electric heat coil, reheat coil or motor. Properly mount control package. Power wiring to and including disconnect switch shall be by Division 26 "Electrical".

3.4 FIELD WIRING IN STARTERS, CONTROLLERS AND PANELS

A. Wiring within starters, controllers, and temperature control panels, shall be routed neatly in gutter space, away from moving and/or heat producing parts. Provide suitably rated terminal blocks. Do not place more than two wire connections on pilot device or relay terminal. Where more than two circuit connections are required, use terminal blocks. Provide nylon insulated, ring spade terminal for all control wires. Cables and wires shall be neatly bundled and lashed with nylon cable straps.

END OF SECTION 23 05 04

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SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. 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.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers:
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
   2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Provide with shaft grounding rings.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves without waterstop.
   2. Sleeves with waterstop.
   3. Sleeve-seal systems.
   4. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

B. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

2.2 SLEEVES WITH WATERSTOP

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   1. Advance Products & Systems, LLC.
   2. CALPICO, Inc.
   3. GPT; an EnPro Industries company.
   4. Metraflex Company (The).

B. Description: Coated steel, stainless steel or galvanized steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   1. Advance Products & Systems, LLC.

2. Airex Manufacturing Inc.
3. CALPICO, Inc.
4. Garlock, Linkseal
5. GPT; an EnPro Industries company.
6. Metraflex Company (The).

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve. Sleeve-seal systems are intended to provide a more robust and tight seal than a traditional sleeve with waterstop.
1. Designed to form a hydrostatic seal of 20 psig.
2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout, seal 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, if insulated.
   3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs 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 space around outside of sleeves.

E. Install sleeves with waterstop where pipe penetrates mechanical room walls.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls. This includes pipe penetrations for the snow melt system.

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 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
   2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above and below Grade:
      a. Sleeve with seal systems.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
         2) Provide sleeve system as required to fit and make tight the penetration for a corrugated plastic tube for the snow melt system.
   2. Concrete Slabs-on-Grade:
      a. Sleeves with seal systems.
         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. Sleeves with waterstops.
   4. Interior Walls and Partitions:
      a. Sleeves without waterstops.
   5. Interior Mechanical Room Walls and Partitions:
      a. Sleeves with waterstops.

END OF SECTION 23 05 17

SECTION 23 05 18 - ESCUTCHEONS FOR HVAC 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.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping and Relocated Existing Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece deep pattern.
      b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
      c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
      d. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
h. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:
   a. Chrome-Plated Piping: Split-plate, stamped steel with concealed exposed-rivet hinge with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping and Relocated Existing Piping: Split floor plate.
   2. Existing Piping to Remain: Split floor plate.

E. All escutcheons in any room shall be of the same material and finish.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 23 05 18

SECTION 23 05 23 – VALVES - GEOTHERMAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation and related Work designed in Contract Documents.

1.2 SUBMITTAL

A. Submit product data for valves and accessories.

PART 2 - PRODUCTS

2.1 VALVES

A. General: Valves shall have following requirements:

1. Working pressure stamped or cast on bodies.

2. Stem packing serviceable without removing valve from line.

3. Valves on insulated services shall have handle extensions so that the handle is fully beyond the insulation jacketing.

4. Where possible, all valves of like type shall be of a single manufacturer.

B. Acceptable Manufacturers:

1. Globe, and Check Valves: Apollo, Hammond, Milwaukee, Nibco, Watts,.

2. Ball Valves: Apollo, Hammond, Jamesbury, Milwaukee, Watts, Nibco.

3. Butterfly Valves: Apollo, DeZurik, Jamesbury, Keystone, Milwaukee, Watts, Nibco.

4. High Performance Butterfly Valves: Keystone, Bray, Velan, Milwaukee.

5. To establish a standard of quality and to identify features, certain manufacturer's numbers are given in the following paragraphs.

C. Ball Valves for Water Service:

1. For geothermal systems 2 in. and under: Bronze body with Type 316 stainless steel ball and stem PTFE seats, full porting, 600 lb., W.O.G., adjustable packing gland, insulated handle, screwed or soldered ends, blowout proof stem. Provide handle extension on insulated services.

2. Provide extended operations handle on non-thermal conductive material and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

D. Valves for Gauges and Instruments:

1. 1/4 in., bronze body, hardened chrome plated brass ball, glass reinforced carbon impregnated seats, standard porting, 400 lb. W.O.G., adjustable packing gland, screwed ends, tee handle, Watts B6000TH.

E. High Performance Butterfly Valves for Water Service:

1. 100% bubble-tight bi-directional shutoff against working pressure of 285 psi when installed between ANSI Class 150 flanges.

2. Body: ANSI Class 150 lug type, carbon steel ASTM A216, or ductile iron. Body to have internally cast travel stops.

3. Disc: 316 stainless steel, beveled construction. Disc and stem shall be of double offset design.

4. Seat: Replaceable Teflon reinforced resilient seat, for water temperatures up to 250°F at 150 psi.

5. Stem: 316 or 416 stainless steel mounted within corrosion resistant bearings.

6. Operators: Valves up to 6 in. with lockable lever operators; valves 8 in. and larger with heavy duty manual hand wheel gear actuators.

7. Keystone Figure 312.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Provide valves of type called for and where required to service equipment.

2. Provide at major building and systems sections.

3. Provide chain wheels, guides, and chain loops for valves, where called for or in Mechanical Rooms where valves are mounted higher than 8'-0" AFF.

4. Locate valves with handles at horizontal position when 5 ft. or more above the floor, for greater visibility and easier use. Otherwise, locate valves with handles at or above horizontal position. Swing check valves in upright position only.

5. Butterfly valves may be used for service over 2 in. unless otherwise noted.

6. Ball valves may be used for water service through 2 in., unless otherwise noted.

7. Provide hose threaded valves at low points, strainers, equipment, and as called for.

END OF SECTION 23 05 23

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SECTION 23 05 23.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.
   3. Stainless Steel ball valves

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges on steel valves.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   5. ASME B16.18 for cast copper solder-joint connections.
   6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
   7. ASME B16.34 for flanged and threaded end connections.
   8. ASME B31.1 for power piping valves.
   9. ASME B31.9 for building services piping valves.

B. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

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

E. Valve Actuator Types:
   1. Hand Lever: For quarter-turn valves smaller than NPS 4.
   2. Gear Actuator: For quarter-turn valves NPS 4 and larger.

F. Valves in Insulated Piping:
   1. Provide 2-inch extended neck stems.
   2. Extended operating handles with nonthermal-conductive covering material, and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Crane Fluid Systems; Crane Co.
   c. Hammond Valve.
   d. Jenkins Valves; a Crane Co. brand.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Stockham; a Crane Co. brand.
   h. WATTS; A Watts Water Technologies Company.
   i. Zurn Industries, LLC.
2. Standard: MSS SP-110.
3. Class: #150
4. SWP Rating: 150 psig.
5. CWP Rating: 600 psig.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Soldered.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

2.3 STAINLESS STEEL BALL VALVES

A. Stainless Steel Ball Valves, Two Piece with Full Port, Threaded:
1. Standard: MSS SP-110.
2. Class: #150
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 INSTALLATION OF VALVES

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

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

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

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

H. Adjust valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, provide the same types of valves with higher SWP classes or CWP ratings.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint.
   2. For Steel Piping, NPS 2 and Smaller: Threaded-joint.

3.4 CHILLED, HEATING AND DUAL TEMPERATURE-WATER VALVE SCHEDULE

A. Copper pipe NPS 2 and Smaller: Brass or bronze ball valves, two piece with stainless steel trim, full port, and solder-joint ends.

B. Steel pipe NPS 2 and Smaller: Stainless steel ball valves, two piece with stainless steel trim, full port, and threaded ends.

END OF SECTION 23 05 23.12

SECTION 23 05 23.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High-performance butterfly valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: ABS, Buna-N, or nitrile butadiene rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 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 butterfly valves closed or slightly open.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B16.5 for flanges on steel valves.

3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building services valves.

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

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

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

E. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
2. Hand Lever: For valves NPS 6 and smaller.

F. Valves in Insulated Piping: Provide with 2-inch extended neck stems.

2.3 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Single-Flange (Lug-Type), High-Performance Butterfly Valves, Class 150:
1. Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
a. NIBCO
b. Watts
c. Apollo
d. RWV
2. Standard: MSS SP-68.
3. CWP Rating: 285 psig at 100 deg F
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: stainless steel.
6. Seat: Reinforced PTFE or metal.
7. Stem: Stainless steel; offset from seat plane.
8. Disc: Type 316 stainless steel.
9. Service: Bidirectional.

2.4 CHAINWHEELS

A. Description: Valve actuation with sprocket rim, chain guides, chain and attachment brackets for mounting chainwheels directly to hand wheels.
1. Sprocket Rim with Chain Guide: Ductile iron, of type and sized required for valve. Include zinc coating.
2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

C. Examine mating flange faces for damage. 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.

D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

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

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

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

E. Install valves in position to allow full valve actuation movement.

F. Install chainwheels on manual actuators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

G. Valve Tags: Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. If leakage cannot be repaired, replace valve.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Single flange, carbon-steel body, and Class 150.

3.5 SOURCE-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Single flange, carbon-steel body, and Class 150.

3.6 HEATING HOT-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Single flange, carbon-steel body, and Class 150.

END OF SECTION 23 05 23.13

SECTION 23 05 48.13 – VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Elastomeric isolation pads.
2. Housed-restrained-spring isolators.
3. Elastomeric hangers.
4. Spring hangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.

2.2 HOUSED-RESTRAINED-SPRING ISOLATORS

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

2.3 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.4 SPRING HANGERS

A. 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 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.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 23 05 48.13

SECTION 23 05 53 - IDENTIFICATION 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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Control valve tags.
7. Warning tags.

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

D. Valve numbering scheme.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

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

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

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160ºF.

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

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

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

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

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

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction in accordance with ASME A13.1.

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

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction, as applicable.
   2. Lettering Size: At least 1-1/2 inches high.

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 labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.

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.
1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain.

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

2.6 CONTROL VALVE TAGS – SIX- AND TWO-WAY VALVES

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Control valve tags to contain valve number, hot and cold water Cv (flow coefficient)
2. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Fasteners: Brass wire-link or beaded chain.

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

2.7 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 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting"

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels 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 labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

D. Pipe Label Color Schedule:
   1. Refrigerant Piping:
      a. Background Color: Blue.
      b. Letter Color: White.

3.4 WARNING-TAG INSTALLATION

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

B. Provide as directed by facility after installation of complete mechanical system, location dependent on final location of equipment, piping, devices etc…

3.5 CONTROL VALVE AND VALVE TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme similar to those indicated below:
   1. Valve-Tag Size and Shape:
      a. Chilled and Chilled Glycol Water: 1-1/2 inches, round or square.
      b. Heating and Heating Glycol Water: 1-1/2 inches, round or square.
      c. Source Water: 1-1/2 inches, round or square.
      d. Ground Water: 1-1/2 inches, round or square.
   2. Valve-Tag Colors:
      a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

END OF SECTION 23 05 53

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

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing, adjusting, and balancing of Air Systems
      a. Variable air volume (VAV) systems, both with and without reheat
      b. Induction-unit systems (active chilled beams)
   2. Testing, adjusting, and balancing of Hydronic Piping Systems:
      a. Variable-flow hydronic systems
      b. Primary-secondary hydronic systems
   3. Procedures for heat transfer coils.
   4. Procedures for motors.
   5. Procedures for exhaust hoods.
   6. Sound tests.
   7. Vibration tests.
   8. Duct leakage tests verification.
   9. Pipe leakage tests verification.
   10. HVAC-control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

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

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: One month prior to the TAB effort, submit sample system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC, NEBB or TABB:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

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

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

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

J. Examine terminal units, such as Variable Air Volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

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

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

O. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes 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. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.
      j. Suitable access to balancing devices and equipment is provided.
   2. Hydronics:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
      b. Piping is complete with terminals installed.
      c. Water treatment is complete.
      d. Systems are flushed, filled, and air purged.
      e. Strainers are pulled and cleaned.
      f. Control valves are functioning in accordance with the sequence of operation.
      g. Shutoff and balance valves have been verified to be 100 percent open.
      h. Pumps are started and proper rotation is verified.
      i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      j. Variable-frequency controllers' startup is complete and safeties are verified.
      k. Suitable access to balancing devices and equipment is provided.
   3. Refrigerant systems:
      a. Verify leakage and pressure tests on refrigerant systems have been satisfactorily completed.
      b. Piping is complete with terminal equipment installed.
      c. Systems are flushed, purged, and charged.
      d. Control valves are functioning in accordance with the sequence of operation.
      e. Suitable access to equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. TAB shall occur as required during commissioning, controls system start up and final building punch lists. TAB shall be an iterative process. As more equipment and controls activate through construction, TAB shall occur on that equipment.

B. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

C. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
   3. Where holes for probes are required in piping, install pressure and temperature test plugs to seal systems.
   4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

D. 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.

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

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

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

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

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

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

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

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

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS (INCLUDING FLOW CONTROL BOXES)

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds 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 set point 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. 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. 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 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 main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

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.
   b. Verify that 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 set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and make sure it is noted during controls start up.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark 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.

3.6 PROCEDURES FOR INDUCTION-UNIT SYSTEMS (ACTIVE CHILLED BEAMS)

A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser, to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.

B. Adjust each induction unit.

C. 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 main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

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 artificial loading of filters at the time static pressures are measured.
3. Review Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

D. 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 submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.

F. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speeds, volts, amps, and 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 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   5. Verify that motor controllers are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
   1. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design flow.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gauge heights.
      d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.9 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
1. Motors.
2. Pumps.
3. Exhaust Fans.

4. Commercial kitchen hoods.
5. Unit heaters/cabinet unit heaters.
6. Energy-recovery units.
7. Roof top units.
8. Air handling units.
9. Makeup air units.
10. Dedicated outside air system units.
11. Variable air volume terminal units w/ reheat.
12. Active chilled beams.
13. Heat pumps.
14. Radiant heaters/panels.
15. Registers, grilles and diffusers.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil in DOAS/AHUs:
1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.11 PROCEDURES FOR MOTORS

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

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.12 PROCEDURES FOR EXHAUST HOODS

A. Room Pressure: Measure and record room pressure with respect to atmosphere and adjacent space with hoods in room initially not operating and then with hoods operating.

B. Makeup Air: Systems supplying source of makeup air to hoods shall be in operation during testing and balancing of exhaust hoods.
   1. Measure and record temperature of makeup air entering hood. If hood makeup air is from multiple sources having different temperatures, measure and record the airflow and temperatures of each source and calculate the weighted average temperature.
   2. Use simulated smoke to observe supply air-distribution air patterns in vicinity of hoods. Consult with hood manufacturer and report conditions that have a detrimental effect on intended capture, containment, and other attributes effecting proper operation.

C. Rooms with Multiple Hoods: Test each hood separately, one at a time, and repeat tests with all hoods intended to operate simultaneously by design.

D. Kitchen Hoods:
   1. Type 1: Measure and record pressure drop and face velocity of hood filters and slots in accordance with hood manufacturer's instructions. Consult hood manufacturer to determine hood airflow using recorded information.
   2. Type 2: Measure and record airflow by duct traverse.
   3. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.

E. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

3.13 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.14 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.15 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
   1. Verify HVAC control system is operating within the design limitations.
   2. Confirm that the sequences of operation are in compliance with Contract Documents.
   3. Verify that controllers are calibrated and function as intended.
   4. Verify that controller set points are as indicated.
   5. Verify the operation of lockout or interlock systems.
   6. Verify the operation of valve and damper actuators.
   7. Verify that controlled devices are properly installed and connected to correct controller.
   8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
   9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.16 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
   2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
   3. Heating-Water, Chilled-Water and Two-Pipe System Flow Rate: Plus or minus 5 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

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

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

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

i. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units
4. Water flow rates.
5. Pipe and valve sizes and locations.

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

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and speed.

c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

G. Iris dampers, for each damper report the following:
1. Airflow
2. Pressure differential
3. Final balanced damper position

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System equipment tag.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.

d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.
2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

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

3.19 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager and Commissioning Authority.

B. Architect or Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. 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."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
   1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
   2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Requirements:
1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 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.

1.3 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.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 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.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
   1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.]

2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

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

C. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Fiber blanket to have 1.5 lb per cubic foot density.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

D. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg for jacketed in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Fiber board to have 3.0 lb per cubic door density.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

a. 3M.
b. Certainteed; SAINT-GOBAIN.
c. Thermal Ceramics.
d. Unifrax Corporation.

2.4 ADHESIVES

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

B. Fiberglass: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.
2. 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).

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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS AND COATINGS

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-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180ºF.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Interior Use: Suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180ºF.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180ºF.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
c. Mon-Eco Industries, Inc.; 44-05.
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 250ºF.
5. Color: Aluminum.

6. 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).
7. 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   c. Mon-Eco Industries, Inc.; 44-05.
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 250ºF.
5. Color: White.
6. 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).
7. 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."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
6. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 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.

2.10 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
   1. 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: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
   1) AGM Industries, Inc.; CHP-1.
   2) GEMCO; Cupped Head Weld Pin.
   3) Midwest Fasteners, Inc.; Cupped Head.
   4) Nelson Stud Welding; CHP.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum stainless-steel 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: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
      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: 0.080-inch nickel-copper alloy.

2.11 CORNER ANGLES

A. 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.

B. 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 Type 316.

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, compress, or otherwise damage insulation or jacket.

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. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

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, but not to the extent of creating wrinkles or areas of compression in the insulation.
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. 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 duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

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 beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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: 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. Comply with requirements in Section 078413 "Penetration Firestopping."

C. Insulation Installation at Floor Penetrations:
   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FIBERGLASS INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.
   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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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.
   5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
   6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 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.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions.

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

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

D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation.

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

3.9 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 unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.

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.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Fiberglass blanket, R-6 installed

B. Concealed, Outdoor-Air Duct and Plenum Insulation: Fiberglass blanket, R-6 installed

C. Concealed, Exhaust-Air Duct and Plenum Insulation between building exterior and first isolation damper or 15’ linear feet: Fiberglass blanket, R-6 installed

D. Exposed, Supply-Air Duct and Plenum Insulation: Fiberglass board, R-6 installed

E. 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.

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

G. Exposed, Outdoor-Air Duct and Plenum Insulation: Fiberglass board, R-6 installed

H. Exposed, Exhaust-Air Duct and Plenum Insulation: Fiberglass board, R-6 installed

I. Concealed oven and ware wash exhaust, Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

J. Concealed oven and ware wash exhaust, Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

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. Ducts and Plenums, Exposed:
1. Aluminum, Stucco Embossed: 0.016 inch thick.

END OF SECTION 23 07 13

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating HVAC equipment that is not factory insulated.

B. Related Sections:
1. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

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

1.3 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.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or 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

1.5 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 equipment Installer for equipment insulation application.

1.6 SCHEDULING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, 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. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Indoor Equipment Insulation Schedule," articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.
   1. Block Insulation: Type I.
   2. Special-Shaped Insulation: Type III.
   3. Board Insulation: Type IV.
   4. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
   5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

C. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

D. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.
   1. Semirigid board material with factory-applied FSK jacket.
   2. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

E. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III, with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article

2.3 ADHESIVES

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

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
   1. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
   2. Wet Flash Point: Below 0 deg F
   3. Service Temperature Range: 40 to 200 deg F.
   4. Color: Black.

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

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

2.4 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water-Based: Suitable for indoor and outdoor use on below-ambient services.
   1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
   2. Service Temperature Range: 0 to plus 180 deg F.
   3. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
   4. Color: White

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
   2. Service Temperature Range: 0 to plus 180 deg F.
   3. Color: White.

2.5 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:
   1. Permanently flexible, elastomeric sealant.
   2. Service Temperature Range: Minus 58 to plus 176 deg F.
   3. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:
   1. Fire- and water-resistant, flexible, elastomeric sealant.
   2. Service Temperature Range: Minus 40 to plus 250 deg F.
   3. Color: Aluminum.

D. ASJ Flashing Sealants:
   1. Fire- and water-resistant, flexible, elastomeric sealant.
   2. Service Temperature Range: Minus 40 to plus 250 deg F.
   3. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 4 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. 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.

2.10 SECUREMENTS

A. 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.
   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.
   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.
      a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank; length to suit depth of insulation indicated.
      c. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   b. Spindle: Nylon, 0.106-inch-diameter shank; length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-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.
   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed; 0.106-inch-diameter shank; length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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

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

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, 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 in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Coordinate insulation installation with the tradesman 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.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

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 storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

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 attached to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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, but not to the extent of creating wrinkles or areas of compression in the insulation.

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. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

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 beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. 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.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Glass-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive, anchor pins, and speed washers.
1. Apply adhesives in accordance with 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 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 and replaceable 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.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from galvanized steel or stainless steel, at least 0.040 inch 0.050 inch 0.060 inch thick.
3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

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

3.5 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.

3.6 FINISHES

A. Equipment 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 Project Engineer. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum jackets.

3.7 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. 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: Inspect field-insulated equipment, randomly selected by Project Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each type of equipment defined in "Indoor Equipment Insulation Schedule".

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 EQUIPMENT INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable 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 is Contractor's option.

3.9 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor equipment that is not factory insulated. Equipment to be insulated includes but is not limited to the following:

B. Pump insulation shall be the following:
1. Glass-Fiber Board: 2 inches thick and 3 lb/cu. ft. nominal density.

C. Expansion tank insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Glass-Fiber Board: 1 inch thick and 3 lb/cu. ft. nominal density.
3. Glass-Fiber Pipe and Tank: 1 inch thick.

D. Air-separator insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Glass-Fiber Board: 1 inch thick and 3 lb/cu. ft. nominal density.
3. Glass-Fiber Pipe and Tank: 1 inch thick.

E. Heat Exchanger insulation shall be one the following:
1. Glass-Fiber Blanket: 1 inch thick and 3 lb/cu. ft. nominal density.
2. Contractor may use a propriety insulation cover specifically for plate and frame heat exchangers after submitting to and receiving approval from the Engineer of Record.

F. Control valve insulation shall be the following:
1. Boxed out with 1” thick, glued together closed cell insulation

G. Balance Valves in Valve Closet insulation shall be the following:
1. Glass-fiber blanket: 1 inch thick and 3 lb/cu. ft. nominal density.

END OF SECTION 23 07 16

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. Heating hot-water piping, indoors.
   2. Chilled water piping, indoors.
   3. Cooling coil condensate drains, indoors.
   4. Dual temperature piping, indoors.
   5. Source water piping, indoors.
   6. Refrigerant piping, indoors.
   7. Snow melt hot-water piping, indoors and outdoors.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230716 “HVAC Equipment Installation.”

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 pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties.
   5. Detail application of field-applied jackets.
   6. 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 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.

1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

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

F. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.
   1. Manufacturers: Subject to compliance with requirements, available Manufacturers that may be incorporated into the Work include the following:
      a. Fibrex Insulations Inc.;
      b. Johns Manville
      c. Knauf Insulation
      d. Manson Insulation
      e. Owens Corning

G. Fiber-Glass, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: 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.

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. Glass/Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.
2. 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).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

D. Flexible Elastomeric Adhesive: Solvent Based adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Armaflex, 520 BLV or 625
b. K-Flex USA 373
c. Aeroflex USA, Inc.; Aeroseal
2. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F
4. Service Temperature Range: 40 to 200 deg F
5. Color: Black, or as coordinate with Architect

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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation, 749.
c. Childers, CP-30 Chil-Perm LO.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 permat 43-mildry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.

b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 permat 30-mildry 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.

2.4 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 vapor barrier.

2.5 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.

5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.6 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
c. Johns Manville; JM Cladding Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with 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. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

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

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. 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 Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.

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

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

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

3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one

pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

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

3.6 INSTALLATION OF FIBERGLASS 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 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, 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.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

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

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
   2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Apply PVC jackets on all indoor pipe fittings, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

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

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

3.9 FACTORY-APPLIED JACKET INSULATION

1. PEX-a piping for the snow melt system shall come factory pre-insulated in a double pipe arrangement.
2. The insulation shall cosist of microcellular, cross-linked polyethylene closed cell foam.
3. Water absorption after 28 days shall be rated by DIN 53248, <1.04% of volume.
4. The jacket shall be UV protected high density polyethylene (HDPE).
5. Pipe and pipe insulation to arrive in one full coil for a continuous connection between the manifold and the concrete slab.

3.10 FINISHES

A. Pipe Insulation with ASJ: 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.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

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

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.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 105-140 Deg F:
   1. NPS < 1": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1" inch thick, R-value of R-5
   2. NPS 1" to < 1 ½": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1" inches thick, R-Value of R-9
   3. NPS 1 ½" to < 8": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1-1/2" inches thick, R-Value of R-8
   4. NPS 8" >: Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1-1/2" inches thick, R-Value of R-7

B. Chilled Water Supply and Return, 40-60 Deg F:
   1. NPS < 1" to < 1 ½": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: ½" inch thick, R-value of R-2
   2. NPS 1 ½" to > 8": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1" inches thick, R-Value of R-5

C. Dual Temperature Supply and Return, 105-140 or 40-60 Deg F:
   1. NPS < 1": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1" inch thick, R-value of R-5
   2. NPS 1" to < 1 ½": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1" inches thick, R-Value of R-9
   3. NPS 1 ½" to < 8": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1-1/2" inches thick, R-Value of R-8

D. Source Water Supply and Return, 40-60 Deg F:
   1. NPS < 1" to < 1 ½": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: ½" inch thick, R-value of R-2
   2. NPS 1 ½" to > 8": Insulation shall be the following:
      a. Fiberglass, Preformed Pipe, Type I: 1" inches thick, R-Value of R-5

E. Refrigerant Suction and Hot Gas Tubing, indoors and outdoors:
   1. All Pipe Sizes: Insulation is the following
      a. Flexible Elastomeric: 2 inches thick.

F. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation is the following:
      a. Flexible Elastomeric: 1/2 inch thick.

G. PEX Snow Melt Piping from pipe manifold to exterior wall:
    a. Factory pre-insulated piping with corrugated HDPE cover, R-Value of R-4

3.14 OUTDOOR PIPING INSULATION SCHEDULE:

A. PEX Snow Melt Piping from exterior wall to slab:
    a. Factory pre-insulated piping with corrugated HDPE cover, R-Value of R-4

END OF SECTION 23 07 19

23 08 00 - COMMISSIONING OF HVAC

- Please note that the selection of a project Commissioning Authority (CxA) is still pending. Modifications to the scope of services outlined in Directive 1B-6 may be required and will be determined by the Fund and the selected consultant CxA. Any authorized CxA scope of work modifications will be communicated to the Architectural and Engineering Design Team for implementation of required changes to the construction documents by formal Addenda.

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section describes the commissioning requirements for the Corey Union Renovation Project at SUNY Cortland.

B. Commissioning shall comply with SUCF Directive 1B-6 and the New York State Energy Code commissioning requirements.

C. All commissioning activities shall be incorporated into the Contractor's Work, including scheduling, manpower, equipment access, documentation, testing, and corrections.

D. A Commissioning Agent (CxA) will be engaged by the Owner under separate contract. Until such time, these requirements form the basis of commissioning for the Project.

1.2 COMMISSIONING OBJECTIVES

A. Verify installed systems conform to the Contract Documents and are fully functional.

B. Confirm that systems achieve design performance under all operating modes.

C. Confirm complete start-up, TAB verification, control implementation, training, and documentation.

D. Provide commissioning documentation suitable for long-term operation and maintenance.

1.3 SYSTEMS TO BE COMMISSIONED

(*HVAC Systems Only*)

A. Commissioning applies to the following systems:
   1. Geothermal heat pumps
   2. Geothermal hydronic distribution systems including pumps, headers, and heat exchangers
   3. Dedicated Outdoor Air Units (DOAS)

4. Air Handling Units (AHUs) with energy recovery where applicable
5. Active chilled beams
6. Cabinet unit heaters and hydronic unit heaters
7. Radiators and other terminal heating units
8. Exhaust systems including kitchen, dishwasher, and toilet
9. Make-Up Air Units
10. Building Automation System (BAS), including controllers, sensors, and integration devices

B. Existing local cooling units and exhaust equipment that remain shall be commissioned only where noted.

C. This Project does not include a chiller plant. All references to chilled water systems have been removed.

1.4 SUBMITTALS

A. Commissioning coordination schedule

B. Pre-Functional Checklists (PFCs)

C. Start-up documentation completed by manufacturers' authorized personnel

D. Testing, Adjusting and Balancing (TAB) Plan and Final TAB Report

E. Functional Performance Test (FPT) procedures and results

F. BAS point-to-point checklists and final trending configuration

G. Training plan, materials, and attendance records

H. Systems Manual

1.5 COMMISSIONING MEETINGS

A. Conduct commissioning kickoff meeting at the start of construction phase.

B. Conduct periodic commissioning meetings throughout construction.

C. Conduct weekly coordination meetings during functional testing.

1.6 COORDINATION

A. Coordinate Work with CxA at all stages of construction.

B. Provide minimum 7-day advance notice to CxA for all testing.

C. Provide safe access to all locations requiring verification or testing.

1.7 TRAINING REQUIREMENTS

A. Provide training on installed systems including:
   1. System components and normal operation
   2. BAS navigation, alarms, overrides, trending
   3. Seasonal changeover requirements

B. Training shall be recorded and turned over to the Owner.

1.8 SYSTEMS MANUAL

A. Provide Systems Manual including:
   1. Final O&M manuals
   2. Final approved sequences of operation
   3. As-built control documentation
   4. Recommended seasonal testing procedures
   5. Commissioning reports including seasonal data

PART 2 - PRODUCTS

2.1 TESTING ACCESSORIES

A. Provide test ports, pressure and temperature taps, and sensor access points as required for commissioning on:
   1. Hydronic distribution piping
   2. Geothermal headers / manifolds
   3. Pumps and heat exchangers
   4. Coils in DOAS and AHU equipment

B. Provide temporary equipment required to support testing, including ladders, lifts, calibration instruments, and temporary utilities where required.

PART 3 - EXECUTION

3.1 INSTALLATION VERIFICATION

A. Verify equipment is installed per manufacturer requirements and contract documents.

B. Verify required service and access clearances.

C. Verify labeling and identification of equipment and controls are complete.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. Complete PFCs for each equipment item prior to functional testing.

B. Submit completed checklists to the CxA.

3.3 START-UP

A. Start-up shall be performed by factory-authorized technicians.

B. Provide completed forms, test data, and warranty activation documents to the CxA.

3.4 TESTING, ADJUSTING, AND BALANCING

1. TAB Contractor shall submit TAB Plan to CxA for review prior to performing Work.

2. TAB shall be completed and Final TAB Report accepted by CxA prior to Functional Testing.

3. TAB shall verify airflow, hydronic flow, temperature, and pressure performance.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. CxA will direct and witness FPT.

B. Contractor shall operate systems through all sequences of operation including:
1. Geothermal heating and cooling mode operation
2. DOAS and AHU airflow and energy recovery operation
3. Humidity and condensation management for chilled beams
4. Exhaust and MUA interlocks
5. BAS control operation
6. Alarms, overrides, and trending verification

C. Terminal devices shall be tested using sampling procedures prescribed by the CxA.

D. Document all deficiencies for resolution.

3.6 DEFICIENCY CORRECTION

A. Correct all deficiencies identified by the CxA.

B. Re-test affected systems following correction.

3.7 SEASONAL TESTING

A. Perform deferred testing when outdoor conditions permit performance verification in cooling or heating modes.

B. CxA will verify performance and update findings in Final Commissioning Report.

3.8 FINAL COMMISSIONING REPORT

A. CxA shall submit Final Report including:
1. PFC and FPT results

2. Deficiency and corrective action records
3. Seasonal test results
4. Recommendations for continued operation

END OF SECTION 23 08 00

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SECTION 23 09 23 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary, and Special Conditions, and Division 1 - General Requirements, apply to work specified in this section. Contractor must be familiar with the terms of the above documents.

1.2 RELATED SECTIONS

A. Section 23 05 19 Meters and Gauges for HVAC Piping

B. Section 23 05 93 Testing, Adjusting, and Balancing for HVAC

C. Section 23 73 13.19 Custom Air Handling and Dedicated Outside Air Units

D. Division 22 – variable frequency drives for Plumbing

E. Division 23 – variable frequency drives for HVAC

F. Division 26 – variable frequency drives for HVAC and Plumbing

G. Division 26 – networking and communication cabling shall apply to this section

H. Division 27 – networking and communication cabling shall apply to this section

I. Any sections on labeling of equipment should apply to this section.

1.3 QUALIFICATIONS OF BIDDER

A. Provide an extension of the existing SUNY Cortland Campus- Automated Logic or Delta Controls Building Automation System. Other Building Automation System (BAS) manufacturers shall not be acceptable.

B. All Work of this Division shall be coordinated and provided by the Contractor.

C. All controllers and control devices shall be an extension of the existing Campus - Wide Automated Logic Corporation “WebCTRL” or Delta Conbtrols “EnteliWEB” application. The new control components shall seamless integrate with the existing Automated Logic Corporation or Delta Controls applications.

D. Qualified Bidder Contact Information:
   1. Air Temp Heating and Air Conditioning Inc (ALC Rep) – Binghamton, NY 607-772-8362
   2. Integrated Facilities Systems Inc (Delta Controls Rep) – Cicero, NY 315-423-5406

1.4 SCOPE OF WORK

A. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for on the drawings. At a minimum, provide controls for the following:
   1. New controls for new HVAC heating and cooling equipment.
   2. Control point temp monitoring.
   3. Application software upgrade license
   4. BACnet integration card for existing Boilers
   5. Monitoring of airflow stations throughout the new duct systems, as indicated by the drawings.

B. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Digital Control Units, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system.

C. The contractor shall review and study all HVAC drawings and the entire specification to become familiarized with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

D. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the Contractor and representatives of the Owner will review and check out the system. At that time, the contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

E. All work performed under this section of the specifications will comply with all codes, laws and governing bodies. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits, licenses, software security certificates, and web-application security certificates.

F. 120 volt AC power shall be provided to each BAS panel in the building under the Division 26 scope of work. Emergency Standby electric power circuit from the emergency generator shall be provided to the BAS control panels for:
   1. Existing Boiler controllers
   2. Hot water primary and secondary pumps and controllers
   3. Air Handling Equipment Controllers
   4. Radiant heating equipment controllers and valves.

G. Power Failure Operational Intent: Upon loss in normal power, emergency standby power systems will turn on, “Building Emergency Standby Generator”. Once the “Building Emergency Standby Generator” turns on noted Building Automation System Controllers for Emergency Heating Operations will turn on. This is for the natural gas boiler system, circulator hydronic pumps for boiler system, primary and secondary circulating hydronic

heating pumps, radiant heating equipment, and all the associated controllers and valves associated with the noted Emergency Heating Operation components.

H. Contractor shall identify all BAS panel locations. BAS Panel Locations shall include an Ethernet Drop with network demarcation point at ALL BAS panel locations.

I. In Mechanical Equipment Rooms, Contractor shall identify all BAS panel locations and shall include TWO (2) Ethernet Drop with network demarcation point at ALL BAS panel locations within Mechanical Equipment Rooms.

J. In Valve Closets, Contractor shall identify all BAS panel locations and shall include ONE (1) Ethernet Drop with network demarcation point at the BAS panel location within the Valve Closet.

K. It shall be the responsibility of the control contractor to run all power and control wiring from their control panel to any sub panels, controllers, equipment, etc…. All work shall be performed in compliance with the latest version of the National Electrical Code.
   1. All power wiring shall be installed in EMT conduit
   2. All power AND control wiring in concealed Mechanical Spaces shall be run in EMT conduit.
   3. All power and control wire in exposed “Finished Spaces” shall be run in wiremold, ivory color, coordinate location and routing with plans and asbestos drawings such that asbestos containing material is not disturbed during installation of wire mold. Steel wire-mold, type V2000, or equal. Verify and provide shop drawings of wire routing prior to purchasing any equipment. Coordinate color with project architect.
   4. In no case shall bare exposed control wire be run in mechanical spaces or finished spaces
   5. Control wire may be run in ceiling plenums, supported by bridal rings, if the wire is “plenum rated cable”.

L. It shall be the responsibility of The Contractor to update control graphics at the building automation system operator work station. The Contractor shall remove graphics and interfaces associated with removed systems and equipment, and provide new graphics for all new systems and equipment, as outlined in the contract documents.

M. The system shall be fully integrated with end-to-end communication and functionality. Limited exceptions to end to end communication and functionally may existing in stand-alone or proprietary control operations. Acceptable examples of stand alone or proprietary control operations would be water source heat pump central control.

N. The contractor shall provide a 120V to 24V transformer to power VAV and VAV with reheat control boxes. 120V power to the 24V Transformers to be by the contractor.

1.5 SYSTEM DESCRIPTION

A. For this project the system shall consist of the following components:

B. Network 1: Campus Information Resources Network

1. Network 1 is the highest level of the building management system. This is the network the central campus BAS servers use to communicate with building systems via Network 1 subnetworks. Within the building, the network 1 subnetwork will have vertical risers and horizontal risers. Within the building the network 1 work will be under Division 26 and 27 Networking and Cabling Scope, it is introduced here for clarity.
    a. Vertical risers shall be fiber extending from the MDF to IDF closets. Typically these IDF closets are located on each floor in each major building wing, actual riser architecture will be building specific.
    b. In the IDF closets, patch bays, ethernet switches, etc.. are rack mounted and connected to each other with Ethernet cables.
    c. Network 1 and network 2 will have dedicated demarcation points, these will be under the scope of Network 1. All BAS Connections to Network 1 will be via a dedicated Demarcation Point.
    d. Refer to Division 26 and 27 Networking and Cabling for more information.

C. Network 2: Building Automation System
1. Network 2: Network 2 is a segmented intra-building BAS Communications System, it's scope will be covered in this 23 09 23 Direct Digital Control (DDC) System for HVAC Specification. Network 2 will be provided by the Contractor as described in this Specification. Network 2 provides the BACnet IP communications over ethernet cable between devices.
2. General: Network 2 segments shall not exceed logical building and maintenance level understanding for quick and efficient troubleshooting in the field, meaning, network 2 segments shall not extend to other floors from single control cabinet. Network 2 segments shall be logically grouped for section of floor plan, either mechanical equipment room, wing of building, or partial wing of building dividing in consistent groups, like "North" and "South". Network 2 segments shall be limited in device connections to between 8 – 10 devices.
3. Network 2 Design, Installation and Testing
    a. Network 2 design, installation and testing shall comply with SUNY Cortland 'Communication Design Requirements Section 270500'.
4. Daisy Chained Network 2 Segment Structure
    a. Dual Ethernet port BAS controllers may be Daisy-chained to provide BACnet IP over Ethernet communication over a Network 2 segment if the dual port controllers are designed for Daisy-Chained connection
    b. Daisy chained BACnet IP over ethernet is preferred over daisy chained BACnet MSTP.
5. BAS Switched Network 2 Segments
    a. Where Dual Ethernet ported controllers are not available, a BAS provided Network 2 switch may be installed to allow BACnet IP over Ethernet communications to multiple Network 2 controllers. This Network 2 switch would be referred to as an unmanaged switch with Ethernet based devices on the BAS Network 2.
    b. Each Network 2 switch is limited to a single Network 2 segment. Each segment is limited to a single BAS switch
6. Room Controller Cabinet Locations

a. Group daisy chained Ethernet room controllers in floor level cabinets where feasible
1) Mechanical Equipment Rooms
a) Mechanical Equipment Rooms shall have a minimum of two network 1 demarcation locations for building automation equipment.
b) Valve Rooms
2) Valve Rooms shall have a minimum of one network 1 demarcation location for building automation equipment.

7. Single Controller Cabinets
a. Contractor to avoid use of single control cabinets where possible
b. Group similar controllers in the area together where feasible.

D. Network 3: Building Automation Sub-network
1. BAS Application systems that offer different communication protocols are acceptable. These include
a. BACNet IP
b. BACnet MS/TP
c. Modbus
d. Serial

E. Operator Workstations:
1. System shall be accessible to existing Operator Workstations via campus Ethernet communication system.
2. SUNY Cortland IT Department will provide port/IP address for control system panels. The contractor is responsible for providing all power wiring, cabling, data drops, etc necessary for all control system panels.
3. Contractor shall provide excel document with all port locations, port IPs, associated device type, label, MAC Addresses, summary of this sheet shall be printed out and inserted in sleeve inside each control panel so device information is easily available and accessible during maintenance and servicing.

1.6 WORK BY ASSOCIATED TRADES

A. The Contractor shall furnish all control valves, sensor wells and other similar equipment for installation unless indicated otherwise.

B. The Contractor shall provide field supervision to the designated contractor for the installation of the following:
1. All field devices.

C. The Contractor shall provide:
1. All power wiring to actuator motors, heat trace, and to junction boxes for power to BAS panels.
2. Power wiring for circuits to control panels that require emergency power.
3. Conduit, all temperature control wiring shall be run in conduit.

D. Code Compliance:

1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
2. All wiring shall conform to the National Electrical Code.
3. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
4. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.7 ACTION SUBMITTALS

A. All shop drawings shall be prepared in Visio Professional, AutoCAD software, Revit or other CADD software. The Contractor shall provide a both the drawings in their native format and in PDF.

B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate. Indicate on plans the location and elevation of all controller cabinets relative to adjacent to equipment and infrastructure.

C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.

D. For each 6-way characterized control valve, submit the following:
1. Chilled beam or fan coil identification tag
2. Valve tag ID (Coordinate valve ID on BAS shop drawing. Valve ID to match bid documents)
3. Hot gpm full flow
4. Cold gpm full flow
5. Hot Cv
6. Cold Cv
7. Hand Orientation (coordinate with valve closet piping)
8. Body pipe size

E. For each 2-way ePIV and 2-way characterized terminal unit control valve, submit the following:
1. Chilled beam or fan coil identification tag
2. Valve tag ID (Coordinate valve ID on BAS shop drawing. Valve ID to match bid documents)
3. Hot gpm full flow
4. Cold gpm full flow
5. Hot Cv
6. Cold Cv
7. Hand Orientation (coordinate with piping)
8. Body pipe size

F. Control valve submittals shall not be reviewed by the engineer without the valve tagging, flow, Cv and other data above

1.8 SYSTEM STARTUP & COMMISSIONING

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period.

B. The contractor shall commission and set in operating condition all major equipment and systems, such as all air handling systems, etc., in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.

C. The Contractor shall provide all manpower and engineering services required for testing, adjusting, and balancing all systems in the building. The Contractor shall have a trained technician available on request during the balancing of the systems. The Contractor shall coordinate all requirements to provide a complete air and water balance and shall include all labor and materials in his contract.

1.9 TRAINING

A. The Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel as described below.

B. On-site training shall consist of four (4) 3-hour training sessions that are recorded both audio and video recording of the session.

C. Two (2) of the 3-hour training sessions shall be conducted on different days within three months of what is defined as the project being "substantially complete". ALL systems shall be operational and functioning as intended as deemed by the Owner, Architect, and Commissioning Authority. If any party deems systems are not operational, training can NOT proceed.

D. Two (2) of the 3-hour training sessions shall be conducted 50-weeks after the first session. This second session of training may be a repeat of information from the earlier training session so as to provide an overview and understanding of system operation over the prior 50-weeks. Careful coordination and identification of any specific changes in the sequence of operation during the time lapsed between training sessions will be coordinated with Architect, Engineer of Record, Owner, and Commissioning Authority.

E. Training session shall have capacity and space for at least 12 - 15 individuals per session.

F. The curriculum shall include:
   1. Site walk through and system / equipment overview
   2. System Overview.

3. System Software and Operation:
   a. System access.
   b. Software features overview.
   c. Changing set points and other attributes.
   d. Scheduling.
   e. Editing programmed variables.
   f. Displaying color graphics.
   g. Running reports.
   h. Workstation maintenance.
   i. Application programming.
4. Operational sequences including start-up, shutdown, adjusting and balancing.
5. Equipment maintenance.

1.10 OPERATING AND MAINTENANCE MANUALS

A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates.

B. Following project completion and testing, the contractor will submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software in the native electronic format.

1.11 WARRANTY

A. The contractor shall warrant the system for 12 months after system acceptance and beneficial use by the owner. During the warranty period, the contractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the specification.

PART 2 - PRODUCTS

2.1 SYSTEM ARCHITECTURE

A. General:
   1. The Building Automation System (BAS) shall consist of Network Router/Controllers (RCs), a family of Digital Control Units (DCUs), Administration and Programming Work Applications that then tie into and work with the existing SUNY Cortland Web-based Operator Workstations (WOWs), and File Servers to support system configurations. The BAS shall provide control, alarm detection, scheduling, trending, reporting and information management for the entire facility, and Virtual Limited Area Network (VLAN) if applicable, from a single ODBC-compliant database.
   2. The system shall be designed with a top-level 10/100bT Ethernet network Router / Controller, using the Automated Logic or Delta Controls protocol.

3. Network 1 must not depend on STP or RSTP Protocols to prevent redundant loops and communication storms.
4. A single BACNet Broadcast Management Device shall manage BACNet communications for the building. No HVAC BACNet communications shall be broadcast except through the BBMD.
5. Network 2 shall not communicate with other buildings.

B. Network 1:
1. Shall be an Ethernet 10/100bT LAN/WAN/VLAN. Router/Controllers, Operator Workstations, and the File Server shall connect directly to this network without the need for Gateway devices.

C. Network 2:
1. Main Network 2 devices shall have a minimum speed as an Ethernet 10/100bT. The Level 2 field bus consists of multiple token passing bus protocols that support multiple Digital Control Units for operating HVAC equipment and lighting control systems. Each RC / DCU shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP. Secondary Network 2 physical layer protocol with a limited number of connected devices shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. 'Limited number' meaning within Mechanical Room on Equipment Controllers.

D. BAS LAN Segmentation:
1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database.

E. Standard Network Support:
1. All RCs, Workstation(s) and File Server shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the RC's, Workstation(s) and File Server shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

F. System Expansion:
1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same Network 1 and Network 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. The web-based operator licenses for the existing system shall include a version upgrade, operator license, and system security review with University Information

Resources and existing Server Infrastructure for all security updates and system compliance.

3. The system shall use the same application programming language for all levels: Operator Workstation, Network Router/Controller, and Digital Control Unit.

G. Support For Open Systems Protocols:

1. The BAS design must include solutions for the integration of the following “open systems” protocols and digital data communication to third party microprocessors such as heat pump plant controllers, fire panels and variable frequency drives (VFDs).
2. Automated Logic supports third party integration via BACnet IP, BACnet MSTP and MODBUS. The use of LON, N2, Apogee or other protocols shall not be acceptable.
3. The system shall also provide the ability to program custom ASCII communication drivers for communication to third party systems and devices. These drivers will provide real time monitoring and control of the third party systems. Once programmed, these data points shall be monitored and controlled in exactly the same manner as native BAS data points.

2.2 ROUTER/CONTROLLERS (RCs)

A. General:

1. Network Router Controllers shall combine both network routing functions and control functions into a single unit. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler. A sufficient number of RCs shall be supplied to fully meet the requirements of this specification and sequence of operations.

B. Hardware Specifications:

1. Memory:
   a. Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Communication Ports:
   a. Each RC shall provide communication to both the Workstation(s) and the field buses. An on-board 10/100bT Ethernet port shall be provided, as well as an onboard 10/100bT Ethernet service port.

C. Modular Expandability:

1. The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various sizes. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

D. Local Status Indicator Lamps:

1. Provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each output, provide LED indication of the value of the output

(On/Off). For each output module provide an LED which gives a visual indication of whether any outputs on the module are manually overridden.

E. Real Time Clock (RTC):
1. Each RC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

F. Power Supply:
1. The power supply for the RCs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning.

G. Automatic Restart After Power Failure:
1. Upon restoration of power after an outage, the RC shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

H. Battery Backup:
1. The RC shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the RC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the RC shall restart itself from its application program stored in its FLASH memory.

I. Software Specifications:
1. General:
a. The RC shall contain FLASH memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each RC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

J. User Programming Language and Mathematical functions consistent with Automated Logic Corporation and Delta Controls current standards.

K. Energy Management Applications:
1. RCs shall have the ability to perform any or all of the following energy management routines:
a. Time of Day Scheduling.

b. Calendar Based Scheduling.
c. Holiday Scheduling.
d. Temporary Schedule Overrides.
e. Optimal Start.
f. Optimal Stop.
g. Night Setback Control.
h. Demand Control Ventilation.
i. Peak Demand Limiting.
j. Heating/Cooling Interlock.
k. Hot Water Reset.
l. Chilled Water Reset.
m. Water to Water Heat Pump Sequencing.
n. Duct static pressure optimization
o. Ventilation Reset
p. BACnet Network 2 Communication Protocol Management of 3rd Party Devices
q. Initiate Broadcast Communication Notices from Network 2 to Network 1 to Server System to email or text notification of specific Alarm Management Events.

L. History Logging:
1. Each controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user- defined time intervals, or manual command.

M. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the RC and can result in the display of one or more alarm messages or reports.
2. Up to 8 alarms can be configured for each point in the controller.
3. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
4. If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the RC. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm.
5. Specific Operator defined alarms can initiate email or text notifications can be managed within Alarm Management system.

2.3 DIGITAL CONTROL UNITS (DCUS)

A. General:
1. Digital Control Units shall provide control of HVAC and lighting, including air handling units, and other mechanical equipment. Each controller shall be fully

programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated RC.

B. Memory:
1. Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

C. Communication Ports:
1. Shall be an Ethernet 10/100bT LAN/WAN/VLAN.

D. Input/Output:
1. Each DCU shall have enough inputs and outputs to meet the application's required point count. Each DCU shall support universal inputs, whereas any input may be software-defined as:
   a. Digital Inputs for status/alarm contacts.
   b. Counter Inputs for summing pulses from meters.
   c. Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
   d. Analog inputs for pressure, humidity, flow and position measurements.
   e. DCU's must support both digital and analog output types:
      1) Digital Outputs for on/off equipment control.
   f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

E. Expandability:
1. For larger controllers (Over 16 base inputs and up), provide input and output expansion through the use of plug-in modules. A minimum of two I/O modules must be capable of being added to the base DCU.

F. Room Sensor / Zone Sensor:
1. The Digital Control Unit (DCU) shall support a variety of room thermistor or zone sensors offered through the BAS integration application manufacturer, ALC or Delta Controls. Refer to Sequence of Operation for additional room sensor / zone sensor application and requirements. Typical qualities and characteristics include standard cover, an override button or slide adjustment; LCD display; button / keypad for override temperature adjustment and adjustment of override time period. The display sensor shall be able to display the current temperature, setpoint, outside air temperature, relative humidity and setpoint, occupancy mode, and mode (heating / cooling) of the individual zone. Where sensors must be tamper proof, a stainless steel wall plate sensor shall be utilized instead of a guard. Stainless steel wall plate thermistor will include an insulated backing plate. Care should be taken to make sure all thermistor locations are sealed from external sources of drafts, infiltration, exfiltration, and other detrimental environmental factors. The minimum requirements for room sensor / zone sensors for this scope of work include 4 or 6 button interface; LCD Screen; Temperature; Temperature Set Point; Occupancy Mode; Zone Mode; Outside Temperature; Override time

duration count. Select zones (3 per AHU / DOAS / ERV) will have enhanced environmental sensing characteristics in addition to the typical minimum requirements. Enhanced room sensor / zone sensors will also include humidity; dewpoint; carbon dioxide.

G. Networking:
1. Each DCU will be able to exchange information on a peer to peer basis with other Digital Control Units, according to the selected BACnet protocol. Each DCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each DCU shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an RC.

H. Indicator Lamps:
1. DCUs will have as a minimum, LED indication of CPU status, and field bus status.

I. Real Time Clock (RTC):
1. All DCUs shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each DCU shall receive a signal, every hour, over the network from the RC, which synchronizes all DCU real time clocks.

J. Automatic Restart After Power Failure:
1. Upon restoration of power, the DCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

K. Battery Back Up:
1. All DCUs shall store all programming in non-volatile FLASH memory. All DCUs except terminal controllers shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the DCU shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the DCU shall restart itself from its application program stored in its FLASH memory.

L. Software – General:
1. The DCU shall contain FLASH memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each DCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

M. User Programming Language:

1. The application software shall be user programmable, using the same language as that defined for Network Router/Controllers. Controllers that use a “canned” program method will not be accepted.

N. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Router/Controller.

O. History Logging:
1. Each controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user- defined time intervals, or manual command.

P. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the DCU and can result in the display of one or more alarm messages or reports.
2. Up to 8 alarms can be configured for each point in the controller.
3. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
4. If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
5. Boiler Controllers:
   a. Boiler Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.
   b. Boiler Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
   c. Boiler Controllers shall be fully user programmable to allow for modification of the application software.
   d. A manual override switch shall be provided for all digital and analog outputs on the Boiler Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

Q. User Interface:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of user specific logging and experience.

R. User Security:
1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a

system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per license agreement. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.

S. Configuration Interface:
   1. The workstation software shall use a familiar web browser that is compatible with application security certificates and HTTPS protocol. Example, "FireFox TM"-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
   2. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the BAS database. The types of template objects supported shall include all data point types (input, output, string variables, setpoints, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all "child" objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of the child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the BAS.

T. Color Graphic Displays:
   1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change set points from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:
      a. SVGA, bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays.
      b. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust set points, start or stop equipment, modify PID loop parameters, or change schedules.
      c. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

d. Ability to link graphic displays through user-defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required. If separate, provide a copy of the full graphic editing software on each workstation.

U. Automatic monitoring:
1. The software shall allow for the automatic collection of data and reports from any controller through either hardwired or modem communication link. The frequency of data collection shall be completely user-configurable.
2. Alarm Management.

V. The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will beintegrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.

W. Custom Report Generation:
1. The software will contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Each workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it will automatically spawn the associated report editor such as MS Word□.
2. Reports can be of any length and contain any point attributes from any controller on the network.
3. The report generator will have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.
4. It shall be possible to run other executable programs whenever a report is initiated.
5. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
6. Standard reports shall include:
a. Points in each controller.
b. Points in alarm.
c. Disabled points.
d. Overridden points.
e. Operator activity report.
f. Alarm history log.
g. Program listing by controller with status.
h. Network status of each controller.

X. Spreadsheet-Style Reports:
1. The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-

configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to set up each report to display in any text font, color and background color. In addition the report shall be able to be configured to filter data, sort data and highlight data which meets user-defined criteria.

Y. Saving/Reloading:
1. The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

2.4 DDC SENSORS AND POINT HARDWARE

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
1. Available Manufacturers:
a. Automated Logic Corporation
b. Delta Controls
c. BAPI.
2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 72 inches (1830 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor / Zone Sensor Cover Construction: Manufacturer's standard locking covers.
a. Set-Point Adjustment: Visible.
b. Set-Point Indication: Visible.
c. Thermometer: Concealed.
d. Color: Standard Manufacturer’s Color.
e. Orientation: Vertical.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Thermistor Temperature Sensors and Transmitters for AHU/DOAS/HRV/MAU Air Streams:
1. Available Manufacturers:
a. Automated Logic Corporation
b. Delta Controls
c. BAPI.
2. Multiple sensors to provide average temperature across entire length of sensor.

3. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
4. Wire: Twisted, shielded-pair cable.
5. Thermally Isolated Support System in Units: To be provided by manufacturer.
6. Rigid probe of aluminum, copper or stainless steel sheath.
7. Length as required by application to cover entire cross section of the air stream.
8. Wire to control panel through conduit portals provided by the manufacturer.

D. RTDs and Transmitters:
1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Averaging Elements in Ducts: 24 feet (7.3 m) long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
6. Room Sensor / Zone Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Visible
   b. Set-Point Indication: Visible.
   c. Thermometer: Concealed.
   d. Color: Standard Manufacturer’s Color.
   e. Orientation: Vertical.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

E. Smart Humidity Sensors: Bulk polymer sensor element.
1. Manufacturers:
   a. Automated Logic Corporation.
   b. Delta Controls.
   c. BAPI
2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity. Wall-mounted Vaisala Model HMW 60/70 with Humicap 180 Sensor.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Concealed.
   c. Thermometer: Concealed.
   d. Color: Manufacturer’s Standard Color.
   e. Orientation: Vertical.
5. Outside-Air Sensor: Transmitter shall measure relative humidity and temperature from these values: dewpoint, dewpoint/frost temperature, mixing ratio, absolute humidity, enthalpy and calculated. All measured and calculated quantities shall be monitored through the EMS in addition to those points listed in the I/O Summaries. Zero (0) percent to one hundred (100) percent relative humidity range with

mounting enclosure, (Solar Radiation and Precipitation Shield Vaisala Model DTR500) suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F (minus 30 to plus 85 deg C) with +/- 1% RH accuracy between 59 deg F to 77 deg F. Vaisala Model HMT 337 with warmed probe and temperature sensor.

6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity. Vaisala Model HMD 60/70 with Humicap 180 sensor.
7. Indoor Dewpoint Transmitter: Wall-mounted, Vaisala Model DMW19 and or integrated with BAS system Zone Sensor Controller.

F. Pressure Transmitters/Transducers:
   1. Available Manufacturers:
      a. Automated Logic Corporation
      b. BEC Controls Corporation.
      c. General Eastern Instruments.
      d. MAMAC Systems, Inc.
      e. Vaisala.
      f. Rosemount.
      g. Air Monitor, Inc.
      h. Ebtron, Inc.
      i. United Electric.
   2. Square Root Extractor: Integral - User-selectable.
   3. Zeroing: Integral - Manual with 3-way switch.
   4. (7) Natural Spans, from 0 - .10 IN w.c. to 0-10.0 IN w.c. (7) Bi-Polar Spans
   5. Accuracy: +/-0.5% of Natural Span, including non-linearity, hysteresis, and non-repeatability.
   6. Temperature Effect: Zero: 0.015% of Natural Span / EF. Span: 0.015% of Natural Span EF.
   7. Power Supply: 14-40VDC
   8. Power Consumption: 0.5 Watts at 24 VDCOutput Signal: 4-20mADC, 2-wire configuration.Overpressure Limit: 25 psig.
   9. The transmitter shall be by Ebtron.
   10. Dedicated outside air system and air handling units to have photohelic differential pressure sensors provided with them.
   11. Water Pressure Transducers:Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
   12. Water Differential-Pressure Transmitter: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA. – Rosemount 3051 sole source. Provide shutoff valve and 12” dirt leg with drain valve and chained cap for differential pressure sensor piping. Mount sensor to 24”x24”x3/4” AC Plywood mounting board, painted battleship grey No. 4. Secure board to wall with four 5/16” masonry anchors or appropriate anchor for wall type, coordinate with Architect.
   13. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential – United Electric H105K.
   14. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

15. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA.
    c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
    d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa). Duct Static Pressure Traverse Probes. Provide where indicated duct static traverse probe capable of continuously monitoring the duct or system static pressure it serves. Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Said sensors shall not protrude beyond the surface of the probe. The duct static traverse probe shall be of extruded aluminum construction and (except for 3/4” diameter probes with lengths of 24” or less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 0.5%^. The duct static pressure traverse probe shall be the STAT-Probe/1 as manufactured by the Air Monitor Corporation or Gold Series by Ebtron.
    e. Electronic Velocity Pressure Transmitters. The electronic differential pressure/flow transmitters shall be of industrial process control quality with operating features described herein and capable of producing the outlined performances. The transmitter shall be capable of converting signals of static or differential pressure into a 4-20 mADC output signal linear to the sensed pressure. By means of an integral, user-selectable, square root extractor, the transmitter shall be capable of converting the total and static pressure signals for a flow element into a 4-20 mADC output signal linear to airflow velocity or volume, the transmitter shall be furnished with a built-in 3-way zeroing valve. The transmitter shall be furnished within an aluminum NEMA 1 enclosure with external connection terminals for field wiring. The operating span of the transmitter shall have the capability of factory or field calibration down to 40% of its natural span and the transmitter shall meet or exceed the following performance and application criteria.

G. Static Pressure Sensors.
    1. Shielded Room Space Static Pressure Sensor: Provide for each room or space, a shielded static pressure sensor suitable for wall or ceiling surface flush-mounting, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 3/8" FPT takeoff fitting, all contained in a 10 gauge aluminum welded casing, with brush finish on exposed surfaces. These probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 fpm from a radial source. The shielded room or space static pressure sensors shall be the S.A.P./ 3 Shielded Static Air Probes as manufactured by Air Monitor Corporation.

2. Shielded Plenum Static Pressure Sensor: Provide where indicated for each plenum two shielded static pressure sensors suitable for mounting externally on the plenum wall in opposing positions. The plenum pressure sensors shall be complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 3/8" compression elbow takeoff fitting, all contained in a 10 gauge steel welded casing. With polyurethane paint finish on exposed surfaces. These probes shall be capable of sensing the static pressure of the plenum or duct in the proximity of the sensor to within 1% of the actual pressure value. The shielded plenum static pressure sensors shall be the S.A.P./4 Shielded Static Air Probe, as manufactured by Air Monitor Corporation, Santa Rosa, California.
3. Outdoor Static Pressure Sensor: Provide for the room or space static pressure indicating or controlling systems an outdoor static pressure sensor constructed of 10 gauge anodized aluminum with a 2" diameter FPT connection. The outdoor air probe shall be capable of sensing the outside atmospheric air pressure to within 2% of the actual value when subject to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal. Locate where recommended by the Manufacturer. The Static Outside Air Problem shall be the S.O.A.P., as manufactured by Air Monitor Corporation.
4. Duct Static Pressure Traverse Probe: Provide where indicated, duct static traverse probes capable of continuously monitoring the duct or system static pressure it serves. Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Said sensors shall not protrude beyond the surface of the probe. The duct static traverse probes shall be of extruded aluminum construction and (except for 3/4” diameter probes with lengths of 24” or less) shall be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probes shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 1%. The duct static pressure traverse probes shall be the STAT-probe as manufactured by Air Monitor Corporation, or Ebtron.

H. Liquid Leak Detector Sensor and Alarm: The leak pad sensors shall be of a high frequency capacitance technology to monitor for the dielectric change between air and the leaked liquid. The sensor shall be of PVC, polycarbonate, and epoxy wetted parts. There shall be no electronics at the sensor. Power input shall be specified as 24vdc. The alarm relay shall be on DPDT, 5 amp dry contact. Provide liquid leak detectors in each elevator pit and tie into the EMS as a critical alarm.

2.5 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Thermal dispersion type, stainless steel finishes, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
   1. Available Manufacturers:
      a. Automated Logic Corporation
      b. Delta Controls.
      c. BAPI.
      d. IFM Efector, Inc.

2.6 GAS DETECTION EQUIPMENT

A. Available Manufacturers:
   1. Automated Logic Corporation
   2. B. W. Technologies.
   3. CEA Instruments, Inc.
   4. Ebtron, Inc.
   5. Gems Sensors Inc.
   6. Greystone Energy Systems Inc.
   7. Honeywell International Inc.; Home & Building Control.
   8. INTEC Controls, Inc.
   9. I.T.M. Instruments Inc.
   10. MSA Canada Inc.
   11. QEL/Quatrosense Environmental Limited.
   12. Sauter Controls Corporation.
   13. Sensidyne, Inc.
   14. TSI Incorporated.
   15. Vaisala.
   16. Vulcain Inc.

B. Carbon Monoxide Detectors: Single, dual-level detectors using solid-state plug- in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg

F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 or 35 and 200 ppm.

1. Provide in the boiler / mechanical room. Tie into existing control cabinet.
2. If elevated CO, 50 PPM (adjustable) is detected, associated exhaust fan shall turn on.
3. Single Chanel is acceptable integrated Boiler Controller Digital Control Unit.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting. Measurement range shall be 0-2000 ppm, accuracy shall be 20 ppm, repeatability shall be +/- 1% full scale, long term stability shall be 5% over 5 years and response time shall be less than 60 seconds. Provide field calibration kit and turn over to Owner. Sole Source: Vaisala Carbocap GMD/W20 Series, (duct-mounted), GMW21/D and GMW22D for wall-mounted applications and GMP343 for ambient Cox monitoring (i.e., designed for outdoor use).

D. Occupancy Sensor: Product to be ‘Watt Stopper’. Mechanical systems to be controlled based on zone occupancy as detailed in the sequence of operations.

E. Refrigerant Monitoring System
1. If refrigerant leak is detected – audible alarm is annunciated in room with strobe AND outside the space – main entrance and any secondary entrances and additional strobe or strobes and audible alarm horns will be installed to notify building staff of potential refrigerant leak and emergency safety measures should be taken.

F. BAS shall also have visual and audible alarm at the operating application if refrigerant monitor system is tripped. This will also identify the room location and number.

2.7 FLOW MEASURING STATIONS

A. Airflow measuring stations for ducts shall utilize thermal dispersion airflow measurement technology.
1. Available Manufacturers:
   a. Automated Logic Corporation
   b. Ebtron, Inc. – Gold Series.
   c. Sierra.
   d. Kurtz
2. Each sensing point shall be independent and calibrated to NIST Traceable Airflow and Temperature Standards.
3. The microprocessor-based transmitter shall provide linear output signals for both airflow and temperature.
4. Duct and plenum probes shall be Model GP1 or equivalent.
5. Fan inlet probes shall be Model GF1 or equivalent.
6. Transmitters shall be GTx116 or equivalent.
7. Sensor Probe Configurations
   a. Type A (probes x sensors): 2 x 8 (independent sensors)

b. Type B (probes x sensors0: 4 x 4 (independent sensors)

8. Sensor Accuracy:
   a. Airflow: +/- 2% of reading, +/-0.25% repeatability.
   b. Temperature: +/-0.15 deg F (+/-0.08 deg C).
9. Sensor Ranges:
   a. 0 to +5,000 fpm (0 to +25.4 m/s).
   b. Temperature: -20 deg F to 160 deg F (-28.9 deg C to 71.1 deg C)
   c. Humidity: 0 to 99% RH, non-condensing
10. Sensor Distribution: Equal area (standard) or Log-Tchebycheff (Log-T).
11. Sensor Assembly (each sensing point):
   a. Heated element: One bead-in-glass, hermetically sealed, thermistor probe.
   b. Temperature sensor: One bead-in-glass, hermetically sealed, thermistor probe.
   c. Sensor Housing: Glass-filled polypropylene (Kynar with 316 SS option).
   d. Sensor potting material: Marine grade, waterproof epoxy.
   e. Internal wiring: Kynar coated copper.
12. Duct Sizes:
   a. Standard Insertion and Standoff Mounts: 8 inches to 120 inches (1203.2mm to3048 mm). Standard Internal Mount: 12 inches to 120 inches (304.8 mm to 3048 mm).
   b. Custom: 120 inches to 192 inches (3048 mm to 4876.84 mm).
13. Tube Construction
   a. Standard: Gold anodized, 6063 aluminum alloy.
   b. Nominal Tube Diameter: Aluminum: 1.1 inch (27.94 mm); S/S: 1.125 inches (28.575 mm).
   c. Mounting Brackets: type 304 stainless steel.
   d. Mounting Styles: Insertion, Internal or Standoff.
14. Cable Assembly
   a. Type: UL Plenum Rated, Teflon FEP cable for extended operating temperature range and durability.
   b. Length: 10 foot standard (3.048 m), 50 foot (15.24m) maximum.
   c. Termination: 0.875 inches (22.2 mm) plug (transmitter end), gold-plated pins.
15. Plug and Play Sensor Probes: Probes do not require matching to transmitter.
16. Compatible Transmitters: GTA116, GTN116, GTE116, and GTL116.
17. Listings: UL 873 Airflow and Temperature Indicating Devices.
18. Warranty: Thirty-six (36) months after Substantial Completion.

B. See section 23 73 13.19 - CUSTOM AIR HANDLING, DEDICATED OUTSIDE AIR, HEAT RECOVERY, MAKE UP AIR UNITS for information on factory installed, fan mounted, piezometer ring airflow measuring stations. Pneumatic tubing shall be provided from the piezometer ring to the exterior of the air handling unit in the factory. An autozeroing and high precision pneumatic to electronic transducer shall be field provided connected to the BMS.

2.8 THERMOSTATS

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
   a. Occupied Heating: 70 deg F
   b. Occupied Cooling: 76 deg F
   c. Unoccupied Heating: 65 deg F
   d. Unoccupied Cooling: 80 deg F
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on weekday, Saturday, and Sunday or every day of week.
7. Thermostat display features include the following:
   a. Actual room temperature.
   b. Setpoint temperature.
   c. Duration of timed override.
   d. System mode indications include "heating," "off," "fan auto," and "fan on."

B. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:
   1. Reset: Manual.
   2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

C. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet (6 m).
   2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
   3. To be capable of reset from a remote location.

D. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-automatic- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
   1. Bulb Length: Minimum 20 feet (6 m).
   2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
   3. To be capable of reset from a remote location

2.9 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
   c. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
   d. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): 24-V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
11. Run Time: 30 seconds.

2.10 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Valves shall be provided with a positioning relay.

B. Electronic Pressure-Independent (ePIV) Ball Valves with Threaded or Flanged Ends:
1. Available Manufacturers:
   a. Automated Logic Corporation
   b. Belimo

c. Honeywell

2. Performance:

a. Stem Action: Rotary stem travel.
b. Flow Characteristic: Equal percentage.
c. Flow Control: Within 5 percent of set point.
d. Leakage: FCI 70-2, Class IV.
e. Hydronic Pressure Rating: 360 psig.
f. Hydronic Close-off Pressure: 200 pisd (1/2 – 2), 100 psid (2-1/2-6).
g. Process Temperature Range: Between 14 to 250 deg F.
h. Rangeability: 100 to 1.

3. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of 5 to 60 psig.

4. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Nickel plated brass.
c. Ball: Stainless Steel
d. End Connections: Female threaded (NPT) ends.
e. Sensor Housing: Nickel plated brass.
f. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
g. Diaphragm: HNBR or EPDM.
h. O-Rings: EPDM.
i. Stem: Stainless steel.
j. Characterizing Disc: ETFE
k. Select the largest valve body pipe size with required Cv for heating and cooling. Do not substitute smaller valve body, even if the required Cv is available with smaller characterized valve body

5. Construction:

a. Size Range: NPS 2-1/2 to NPS 6.
b. Body: Cast iron.
c. Ball: Stainless Steel
d. End Connections: ANSI 125 Flanges.
e. Sensor Housing: Ductile iron.
f. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
g. Diaphragm: HNBR or EPDM.
h. O-Rings: EPDM.
i. Stem: Stainless steel.
j. Characterizing Disc: Stainless steel.
k. Select the largest valve body pipe size with required Cv for heating and cooling. Do not substitute smaller valve body, even if the required Cv is available with smaller characterized valve body

6. Install ePIV Valves per manufacturer's instructions, including the minimum run of straight pipe required on the valve inlet for accurate flow measuring.

C. Terminal Unit 2-Way Control Valves: Two ports, replaceable plugs and seats, and union and threaded ends.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Belimo
      b. Crane Fluid Systems; Crane Co.
      c. Emerson
   2. NPS 2 (DN 50) and Smaller: Class 125 bronze body, stainless steel trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   3. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, stainless steel trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   4. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   5. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate or the following:
      a. Two Position: Line size.
      b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   6. Flow Characteristics: Two-way valves shall have equal percentage characteristics.
   7. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two- way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. 6-Way Pressure Independent Control Valves (Located in Valve Closets):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Belimo
      b. Crane Fluid Systems; Crane Co.
      c. Xylem (Bell and Gossett)
   2. General:
      a. Control valve shall accurately control flow
      b. Valve shall be a modulating 6-way control device.
      c. Maximum flow setting shall be adjustable to 55 different settings within the range (90 degrees) of the valve size by changing the actuator programming.
      d. 6-way characterized control valves shall have separate, independent Cv capacity for heating and cooling.
      e. Provide factory valve tag. Factory valve tag shall match control valve identification numbers on drawings M632. BMS shop drawing valve tags shall match control valve identification number numbers on drawings M632.
   3. Valve Actuator:
      a. Valve actuator housing shall be rated to IP44 insulation.

b. Actuator shall be driven by a 24Vdc motor, and shall accept 2-10 Vdc, 4-20mA, include resistor to facilitate any of these signals.

4. Valve Housing:
   a. Body: Nickel plated brass
   b. Ball: Stainless Steel
   c. Stem: Stainless Steel
   d. Seats: Teflon
   e. Seat O-ring: EPDM
   f. Characterizing Disk: Stainless Steel
   g. Select the largest valve body pipe size with required Cv for heating and cooling. Do not substitute smaller valve body, even if the required Cv is available with smaller characterized valve body

E. Automatic, Two-Position, High-Performance Butterfly Valves, Two Way:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Belimo
   b. Crane Fluid Systems; Crane Co.
   c. Emerson
2. Source Limitations: Obtain two-way high-performance butterfly valves from single manufacturer.
3. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Flow Characteristic: Linear or modified equal percentage.
   c. Leakage: FCI 70-2, Class VI.
   d. Hydronic Pressure:

      1) Rating: ASME B16.34, Class 150.
      2) Close-off Pressure: Equal to rating.
      3) Pressure Differential (Maximum): 2PSI.

   e. Hydronic Process Temperature Rating: 0 to 250 deg F

   f. Rangeability: 100 to 1.

4. Standards: ASME B16.34, MSS SP-68.
5. Features:

   a. Bidirectional, end-of-line service.
   b. Extended neck of body to accommodate up to 2-inch-thick insulation.
   c. Replaceable seat, disc and shaft bearings/bushings.

6. Construction:

   a. Size Range: NPS 2-1/2 to NPS 36
   b. Body: Cast steel; single flange, fully lugged and suitable for mating to ASME B16.5 or ASME B16.47 flanges.

c. Disc: Stainless steel.
d. Seat: Reinforced PTFE with stainless steel retaining ring.
e. Stem(s): Stainless steel.
f. Stem Bearings: Stainless steel.
g. Stem Packing: PTFE.
h. Corrosion-resistant nameplate indicating the following:

1) Manufacturer's name, model number, and serial number.
2) Body size.
3) Body and trim materials.
4) Body rating.
5) Arrow indicating direction of flow.

2.11 DAMPERS

A. Available Manufacturers:
1. Air Balance Inc.
2. American Warming and Ventilating
3. Ruskin, Inc.

B. Dampers: AMCA-rated, Class I, opposed-blade (proportional control type) design; airfoil shaped double skin construction of 14 gauge equivalent thickness, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-(1.6-mm-) thick galvanized steel with maximum blade width of 6 inches and length of 48 inches. Provide spring returns for all dampers. Dampers shall be Ruskin Type CD60, or equal of American Warming and Ventilating or Air Balancing, Inc. Round dampers shall be Ruskin Type CER 325.
1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Edge Seals, Ultra-Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

2.12 CONTROL CABLE

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

B. All wiring shall be installed in a designated EMT conduit raceway unless otherwise specified. All junction boxes shall have covers painted “Safety Green” and be rigid steel. Minimum size conduit shall be 3/4”.

C. Where it is not possible to conceal raceways in finished locations (i.e., existing masonry walls), surface raceway (wiremold) may be used as approved by the Architect.

D. Individual conductors shall be color-coded and in addition, shall be numbered in the field to identify the particular terminal to which it is attached. Field numbering shall be performed with Brady Markers wrapped around the wire near the terminal connection. All wires shall be terminated with pressure type connectors suitable for wire size, material, and terminal connection.

E. Network Cable Color Code
   1. Network 1 station cable jackets shall be blue.
   2. Network 2 (BAS) Cable jackets shall be green.

2.13 SNOW MELT SENSOR

A. Contractor to provide a snowmelt optical sensor, to be installed directly in the slab. Sensor shall have a heating element on the top face which melts snow while it falls. Sensor shall read the refraction of the melted snow to activate on/off. Contractor shall provide a snow melt sensor socket, for mounting the sensor into the slab.

B. Contractor shall provide a snowmelt controller. The controller shall dictate snow melt operation based on inputs from the snow melt sensor. Snowmelt controller shall be interoperable with the building management system.

2.14 CUSTOM AIR HANDLING UNIT, DOAS, ERV, SMOKE DETECTORS

A. Duct Smoke Detectors shall be provided in all air handling return air systems with an air flow of 2000 cfm or greater and in return air systems for each floor in accordance with NFPA requirements. They shall be designed to provide detection of combustion gases and fire and smoke in air conditioning and ventilating duct systems in compliance with the National Fire Protection Association and Underwriters Laboratories, Inc. Standard UL 167. Duct smoke detectors shall be furnished by the contractor and installed by the custom air handling unit, DOAS, ERV, manufacturer. The Contractor shall provide all interlock wiring to smoke dampers and/or AHU shutdown. The Contractor shall provide all interlock wiring to the Fire Alarm System and all power wiring. Coordinate duct smoke detector types, quantity of contacts, etc., so as to interface directly with the fire alarm system. Coordinate requirements with Divisions 26, 27, and 28.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. General:
   1. Installation of the building automation system shall be performed by the Contractor. The Contractor shall certify all work as proper and complete. Under no

circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Cleanup:
1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

C. Coordination with custom air handling, dedicated outside air and energy recovery unit manufacturer per '23 73 13.19 - CUSTOM AIR HANDLING AND DEDICATED OUTSIDE AIR UNITS' to provide points, control sequences, graphics and trending as indicated on contract drawings.

3.2 WIRING, CONDUIT, AND CABLE

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr.	Per Mfr.

B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal off fittings where exterior conduits enter the building or between areas of high temperature/moisture differential.

E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Teflon wiring (plenum rated) can be run without conduit above suspended ceilings, and other concealed but accessible locations. Mechanical rooms and exposed wiring shall be installed in EMT. Wiring in walls shall be in EMT.

H. In retrofit applications, the use of surface mount raceway shall be acceptable on masonry walls.

3.3 HARDWARE INSTALLATION

A. Installation Practices for Wiring:
1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
3. 120VAC power to control panels shall be provided under Division 26.
4. An ethernet connection shall be provided by in coordination with the Networking / Communication specification. Coordinate applicable ethernet drop needs. Each Ethernet Drop shall be coordinated with the University Networking Department for static IP designations and device configuration. A network demarcation shall be installed between the BAS network system and the telecommunication network. The demarcation shall be installed adjacent to BAS control panels and in an accessible from the floor location, meaning accessible to the BAS demarcation location without the aid of a ladder.
5. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
6. Wire will not be allowed to run across telephone equipment areas.

B. Installation Practices for Field Devices:
1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

C. Enclosures:
1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure

which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.

2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and quarter turn closure. NO KEYS shall be needed to open up the enclosure. The enclosure will be sized for twenty percent spare mounting space. If a keyed enclosure is provided, it shall be replaced at the Contractors expense, no exceptions.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. The wiring within all enclosures shall be run in plastic track.

D. Identification:
1. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
2. All I/O field devices inside FIP's shall be labeled.
3. Inside each Enclosure – summary of all devices, device labels, controlled equipment, points, Device IPs, Device MAC Addresses shall be provided.
4. Close-out documents will include a final schedule of all FIPs, the label of the FIP, room location of FIP, and the list of controlled equipment, control points, Device IPs, Device MAC addresses, as well as any other reference information about the FIP for future servicing and coordination of long term operations.

E. Existing Controls:
1. Existing controls which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement; will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.
   a. Except for the BACnet integration card for the existing Aerco Boilers. Contractor is to replace the BACnet integration card on the existing Aerco Boilers.
2. Contract shall include upgrade of the main BBMD (Building to Building Management Device) to seamlessly work with the existing ALC infrastructure and incorporate new ALC infrastructure for the building behind ONE single BACnet Management Device.
3. Existing Control equipment on IP network shall all be migrated over to new virtual IP subnetwork and IPs and Reprogramming of any existing devices shall be included as part of the scope of work: Boilers, Pump VFDs, Lighting Control Networks

F. Control System Switch-over:
1. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.
2. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.

3. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

G. Location:
1. The location of sensors is per mechanical drawings.
2. Space temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.4 COMMISSIONING AND SYSTEM STARTUP

A. Point to Point Checkout:
1. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
2. Setting up project specific multi-trends for purpose of commissioning and equipment check out shall be the responsibility of the Contractor. Work shall include at least 40 multi-trends, each with a minimum of 3 groups – 3 points each group.

B. Controller and Workstation Checkout:
1. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
2. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended.

END OF SECTION 23 09 23

SECTION 23 20 30 - UNDERGROUND THERMAL PIPING SYSTEMS AND ACCESSORIES - GEOTHERMAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide materials and services as required for the fabrication, supervision and delivery of the underground piping system indicated on the drawings and in the specifications. The material shall be delivered to the site at the manufacturer's expense. This material will be unloaded by the contractor at the Owner's designated area at the contractor's expense. The manufacturer shall provide factory supervision for five (5) working days (40 hours) on site to train and assist the contractor in the handling and installation of the underground piping system and accessories. The manufacturer shall also include factory supervision for one (1) working day (8 hours) on site to assist the contractor in practice of pressure testing of the carrier piping, piping jacket and leak detection system.

B. It is the responsibility of the Contractor to provide all labor, material and equipment to individually pressure test each field assembled jacket joint during the installation of the underground piping. All pressure testing shall be performed at each joint as it is installed and prior to backfilling the underground piping systems. All pressure testing shall be witnessed by the Owner or Owner's Representative. A log shall be kept by installing contractor as to date, time, weather conditions, test results, installer identity and tester identity. Pictures of installed piping in open trench shall be taken for record. Coordinates and inverts of each change in direction and branch tee locations shall be recorded utilizing GPS survey equipment and standards. Testing log and pictures to be included with as built/O&M information.

C. Underground piping is to be routed to inside the mechanical room in the Corey Union Building as part of the underground piping system. Building wall/foundation core/sleeve opening size and location to be coordinated between indoor piping system and underground piping system layouts. Offsets of underground piping system required at building entry point to attain proper entry elevation are to be included as part of underground piping system. Offsets, expansion and anchoring of entry point piping to be included as part of submittal as part of a complete system. Offsets that do not allow for minimum specified ground coverage shall be made as close to building foundation as possible with anchor point located away from foundation wall to not impose any expansion load on building foundation. Waterproof type below grade pipe seals such as "Link-Seal" or equivalent to be provided with piping system for waterproof installation (Refer to piping systems and accessories specification. Piping shall be terminated with a factory plastic to steel or plastic to copper adapter. Other options for the termination of the piping inside the building can be reviewed during submittal process. Termination connection to be coordinated with indoor system type.

1.2 Reference Documents

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

B. Plastic Pipe Institute, PPI.

C. ASTM D2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

D. ASTM D2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

E. ASTM F2880 Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3⁄4 in. to 65 in.

F. ASTM D3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

G. ASTM D3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

H. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

I. ASTM F714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

J. ASTM F2164 Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.

K. ASTM F2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE).

L. ASTM F2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

M. ASTM F3124 Standard Practice for Data Recording the Procedure Used to Produce Heat Butt Fusion Joints in Plastic Piping Systems or Fittings.

N. ASTM F3183 Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint.

O. ASTM F3190 Standard Practice for Heat Fusion Equipment (HFE) Operator Qualification on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Operating temperature and pressure: 160 deg. F and 140 psig.

1.4 SUBMITTAL

A. Polyethylene piping system.

1. Schedule of carrier pipe materials, insulation material, jacketing materials, fittings and connections, anchors, valves, particle insulation and sleeves.

2. Complete dimensioned piping layout and piping details. Submit complete set of installation drawings showing each piping section numbered and located. Piping layout to include all required anchors, expansion loops, offsets for site routing and offsets required for building entry, and underground valving and manholes where called for as a complete system. Certified dimensional as-built drawings/profile of all installed pipe, specials and fittings.

3. Details of fittings and specials such as elbows, tees, outlets, connections, test bulkheads, nozzles or other special items where shown on the Construction Drawings. All connections to jointed gasketed pipe materials, valves or fire hydrants must be restrained and supported in-dependently to withstand the pressure transients, soil settlement, and external loading conditions.

4. The manufacturer shall submit, through the Contractor, a Certificate of Compliance that the pipe and fittings furnished for this project meet or exceed the standards set forth in this specification. The Contractor shall submit these certificates to the Engineer prior to installation of the pipe materials.

5. Provide a certification that personnel responsible for fusing the pipe have been trained and qualified per ASTM F3190

B. Submit Mill Test Certificates from the manufacturer/supplier for all piping. The manufacturer shall incorporate the Mill Test Certificates into the Quality Control Manual. Manufacturers name or trademark shall appear on all fittings and on each length of pipe.

C. Submit Quality Control Manual for the procedures to be performed by the contractor for proper installation and test of the underground piping system.

D. The Contractor shall submit a list of materials to be furnished, the names of the suppliers, and the appropriate shop drawings for all HDPE pipe and fittings. Factory fusion records on all fittings shall be submitted as part of a QC log prior to the materials being sent to the site.

E. The Contractor shall provide written verification for employees who have been trained by the pipe and fitting distributor to preform pipe installation and joint fusing. If employees have not been previously trained, the pipe and fitting distributor shall provide training with written verification of training provided upon training completion.

F. The Contractor shall submit qualifications and resumes for all personnel performing installation, fusing, and supervising of HDPE pipe.

This includes, but is not limited to written, verifiable proof that the Contractor is qualified by the fusion systems manufacturer(s) or the Pipe Distributor as a fully trained user and must comply with qualifications as stated above.

G. Locator tape.

H. Include in each O&M Manual three (3) sets of operation and maintenance manuals, a copy of each approved Shop Drawing, wiring diagrams, piping diagrams, spare parts list and manufacturer's instructions. Include as-built drawings with associated open trench piping installation photos and location/invert data. Include name, address and telephone number of supplier manufacturer Representative and service agency for all major equipment items. Provide a table of contents page and dividers based upon specification section numbers. Bind above items in a three ring binder with name of project on the cover. Deliver three (3) copies to Owner's Representative for review before request for final acceptance.

I. The Contractor shall submit an as-built fusion map showing placement of all electrofusion and butt fusion joints referencing Data-Logger or manually logged files for small diameter fusion machines. Joints shall be numbered individually and accurately and reference the data-logger or manually logged file joint number.

J. Anchoring and expansion loop locations, sizing and details shall be designed by the manufacturer for review with their submittal. Allow for coordination with site utilities.

K. Pipe System Cleaning, Flushing, and Chemical Treatment:

1. Description of equipment proposed for flushing operations.

2. All detergents, emulsifying agents, and treatment chemicals including MSDS.

3. Requirements for water and power.

4. Schematic indicating filters, pumps, water make-up, and disposal water storage tanks.

5. Velocities in the piping system at mains and branches.

L. Quality Assurance:

1. Submit pipe installation field service inspection reports.

2. Submit field quality-control test reports.

3. Submit evidence of laborer(s) qualifications.

4. Submit inspection and test plan.

M. Coordination Drawings:

1. Prior to piping fabrication, the Contractor shall provide coordination drawings to the Engineer of Record for review. These drawings shall show the proposed layout, valve locations, etc., and shall be coordinated with the existing utilities.

2. Detail, to scale, the piping layout with the locations of fusion joints, fittings, valves, and anchors on shop coordination drawings. The drawings shall be prepared by the contractor performing the pipe installation work.

3. Coordination with pipe anchors within building.

4. Coordination with building pipe arrangements.

1.5 QUALITY ASSURANCE

A. The supplier of the piping system shall be responsible for the design of the pre-insulated piping system, including:

1. Selection of jacket pipe size to comply with insulation requirements.

B. The pipe and resin manufacturers shall have at least seven years of experience producing a similar size pipe and similar resin types.

C. The pipe distributor supplying the HDPE pipe must offer fusion training. Only qualified/certified personnel are allowed to perform the joining process. The fusion training organization, upon completion of the assessment, shall issue evidence of qualification that states:

1. Fusion technician's name.

2. Fusion joining technique or techniques for which the operator is qualified.

3. Type of fusion equipment and the pipe size limitations applicable to that fusion equipment.

4. Fusion technician's specific training.

D. Quality control of heat fusion joints shall be performed in accordance with an inspection and test plan, which shall include the number and location of test specimens to be inspected and the methods for doing so.
The butt fusion equipment used in the joining procedure shall be capable of meeting all the following:

1. The equipment and tooling required.

2. The joining surfaces preparation requirements.

3. The heating tool temperature required for fusion.

4. The heating soaking times for each size and wall thickness of pipe.

5. The alignment procedures and acceptable limits.

6. The joining interfacial pressure and hold time requirements.

7. The clamped cooling time requirements.

8. The cooling handling time requirements.

9. The elapsed time required before the joint can be subjected to high stress.

10. Procedural modifications and precautions for cold-weather joining methods.

11. Precautions for inclement weather such as wind or rain.

12. Documentation and traceability of fusions and fusion technician's unique identification marking procedure.

13. Visual assessment acceptance criteria.

14. The production fusion joint destructive test method.

E. The qualified heat fusion joining procedure shall be verified by the underground factory-authorized representative prior to beginning the pipeline construction project by the completion and testing of a test joint. The verification tests shall be done using the project fusion equipment, project fusion operators, and project pipe.

F. The underground pipe factory-authorized representatives shall provide the services of a qualified individual or individuals who will be present during critical periods of the fusion and installation of the system, including but not limited to unloading, joint fusion, valve installation, building penetrations, backfilling, compaction, and testing of the system. The services of this individual or individuals shall be priced as part of the overall project scope and shall not be an extra cost to the owner.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the owner of other rights the owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the contractor under requirements of the Contract Documents.

1.7 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:

1. Notify Engineer, Construction Manager & Owner no fewer than three days in advance of proposed interruption of utility.

2. Do not proceed with interruption of utility without Engineer's and Owner's written permission.

1.8 COORDINATION

A. Coordinate pipe-fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 PRE-INSULATED HDPE HOT WATER SYSTEM (PE-RT):

A. GENERAL:

1. PE-RT material used for the manufacture of polyethylene pipe, tube and fittings shall be PE 4710 high density polyethylene meeting ASTM D3350 cell classification of 445574C and shall be listed in the name of the pipe and fitting manufacturer in PPI (Plastics Pipe Institute) TR-4 with a standard grade HDB rating of 1600 psi at 73°F and 800 psi at 180°F per ASTM D2837. The material shall contain a stabilizer system for high oxidative environments with a CC3 rating per ASTM D3350.

2. The underground thermal piping system and accessories shall be suitable for the ground systems are to be buried in. Manufacturer shall investigate and state suitability of their product in their submittal. Systems submitted with exception based on soil and ground water content limitations shall not be accepted. All systems are to be designed for maintenance free watertight performance over the life of the system.

3. PE-RT pipe shall be manufactured in accordance with ASTM F2619, API 15LE and ASTM F714. The pipe shall be protected against UV degradation with 2-3% carbon black.

4. IPS pipes shall have four, equally spaced, platinum color stripes co-extruded into the pipe outside surface. Stripes printed or painted on the pipe outside surface shall not be acceptable.

5. Pipe shall be marked in accordance with ASTM F2619, API 15LE and ASTM F714.

B. Fittings:

1. Butt Fusion Fittings - Fittings shall be made of matching material to the piping material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.01.A. Fittings shall have a minimum pressure rating equal to or greater than the pipe to which they are joined unless otherwise specified on the plans or accepted by owner/engineer.

   a. Molded fittings shall comply with the requirements of ASTM D3261.

   b. All fabricated elbows, tees, reducing tees and end caps shall be produced and meet the requirements of ASTM F2206, as manufactured by ISCO Industries, Inc or other approved manufacturer holding an ISO 9001 quality system certificate. Each fitting will be marked per ASTM F2206 section 10 including the nominal size and fitting EDR, which will meet or exceed the pipe DR identified for the project. Fabricated fittings shall be manufactured using a data recording device to record fusion pressure and temperature and shall be stamped with unique joint number that corresponds to the joint report. A graphic representation of the temperature and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of 5 years as part of the quality control and will be available upon request of owner. Test results to validate ASTM F2206 section 7.3 and 9 shall be provided to owner or owner's representative upon request.

2. Bolted Connections – Flanged and Mechanical Joint Adapters can be made to ASTM D3261. Flange adapters, if machined, may also meet the requirements of ASTM F2880. Flanges and MJ Adapters shall be fused onto the pipe and have a minimum pressure rating equal to or greater than the pipe unless otherwise specified on the plans.

   a. Metallic back-up rings (Van-Stone style lap joint flanges), shall have a radius on the inside diameter of the bore so as to be compatible with PE-RT Flanges.
   Back up rings shall have bolt pattern that will mate with AWWA C207 Class D (or B or E), ASME/ANSI B 16.5 Class 150, ASME/ANSI B 16.1 Class 125, or ASME/ANSI B16.47 Series A..

   b. Flange assemblies shall be assembled and torqued according to PPI TN-38, "Bolt Torque for Polyethylene Flanged Joints."

   c. Where shown on the drawings, 4" and larger transitions to mechanical joint fittings and valves shall be accomplished using a MJ Adapter with kit. The D.I./HDPE mechanical joint adaptor shall consist of:

      1) A molded or fabricated HDPE mechanical joint transition fitting.

      2) A rubber gasket.

3) A mechanical joint backup drive ring.

4) Corten mechanical joint tee bolts.

3. FUSION UNIT REQUIREMENTS

a. All Fusion Equipment, whether new or used, rented or owned, shall comply with the requirements of ISO 12176-1 “Equipment for Fusion Jointing Polyethylene Systems”.

b. Butt fusion equipment must be in satisfactory working order and the hydraulic system must be leak free. Heater plates shall be free from scrapes, gouges, and have a consistent clean coated surface. The pressure gauge and thermometer should be properly calibrated. When requested by the owner, records showing a maintenance service/inspection within 3 months prior to use for this project shall be provided.

c. Rental Butt Fusion Equipment must be maintained by a McElroy Authorized Service and Repair Center with at least one McElroy Certified Master Mechanic on staff. When re-quested by owner or his authority, an inspection report detailing the components inspected within 3 months prior to arrival at jobsite will be provided.

d. For 16” and larger pipe sizes, the butt fusion machine shall be capable of autonomously calculating the drag pressure and perform the shift sequence autonomously.

C. Insulation:

1. Two-pound density polyurethane foam.

2. 90% to 95% closed cell.

3. K factor of .17 Btuh/sq. ft./deg. F/in.

4. Two-inch minimum insulation thickness.

D. Acceptable Make:

1. Performance Pipe a Division of Chevron Phillips Chemical Company (Platinum Stripe 1800).

2. ISCO Industries (Platinum Stripe 1800).

E. Polyethylene Flange Adapters (MJ for Exterior and Flange for Interior):

1. Flange adapters shall be made with sufficient through-bore length to be clamped in a butt fusion joining machine without the use of a stub-end holder.

2. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasketless sealing, or to restrain the gasket against blow-out.

F. Back-Up Rings (Exterior MJ Adaptors), Lap Joint Flanges (Interior Flange Adapters), and Bolts:

1. Flange adapters shall be fitted with lap joint flanges pressure rated equal to or greater than the mating pipe (ANSI Class 150).

2. The lap joint flange bore shall be chamfered or radiused to provide clearance to the flange adapter radius.

3. Flange bolts and nuts shall be ASTM A194, Grade 2 or higher.

4. Bolt pattern for flange shall be per ANSI B16.5.

5. Back up rings shall be epoxy-coated ductile-iron.

6. Back-up ring bolts shall be high strength, low alloy steel per ASTM 242.

G. Saddle Connections for Air Release Valve:

1. Air release valves shall be installed at all high points in the piping system unless otherwise approved by the Engineer.

2. Service connections, including air releases, shall be electrofusion saddles with a stainless steel threaded outlet. The size of the threaded outlet shall be 1-inch IPS.

3. Piping beyond the threaded outlet shall be 1-inch Type K copper tubing. Electrofusion saddles shall be made from materials required above.

H. Stiffeners:

1. For all hot water valves include stainless steel pipe stiffener per PE-RT pipe manufacturer's recommendations in the MJ adapter.

2. For all chilled water valves include stainless steel pipe stiffener on valves 16 inches and larger per manufacturer's recommendations in the MJ adapter.

3. Additional locations recommended by the piping manufacturer or plastic pipe vendor.

2.2 PRE-INSULATED HDPE CHILLED WATER SYSTEM

A. General:

1. Description: Factory-fabricated piping with carrier pipe, insulation, and jacketing.

2. 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. GF Urecon

b. Tricon

c. Rovanco Piping Systems, Inc.

3. Carrier Pipe: Shall be High Density Polyethylene conforming to properties established by ASTM P-3350 with a cell classification of PE 345464C. Piping system and fittings shall be DR 11 rated for 160 psi at 73°F

B. Fittings:

1. Butt Fusion Fittings - Fittings shall be made of matching material to the piping material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted above. Fittings shall have a minimum pressure rating equal to or greater than the pipe to which they are joined unless otherwise specified on the plans or accepted by owner/engineer.

C. Insulation:

1. Carrier pipe insulation shall be a polyisocyanurate high temp foam injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, >90% closed cell polyisocyanurate with a minimum 2.0 lbs per foot3 density, compressive strength of 30 psi @ 75˚F, a thermal conductivity K factor no higher than 0.14 @ 75˚F per ASTM C-518. Maximum continuous operating temperature of polyisocyanurate foam shall not exceed 300˚F, except for intermittent spikes of 350˚F.

D. Outer Jacketing Material:

1. The outer casing shall be high density polyethylene (HDPE) conforming to ASTM D3350, Type III, Category 5, Class C and Grade P23/P34. With a minimum of 2% by weight of carbon black. 175 mil minimum Seamless HDPE casing required. No FRP overwrap or sprayed jacketing will be allowed.

Minimum jacket thickness shall be in accordance with Table 1.

a. Table 1:

Nominal Pipe Size in Inches	Min. Insulation Thickness (inches)	Jacket Size (OD) in Inches	Jacket Thickness in Mills
1	1.43	4.53	175
2	1.95	6.63	175
4	1.61	8.06	175
6	1.55	10.07	175
8	1.77	12.52	175
10	1.53	14.16	175
12	1.44	15.98	175
14	1.80	17.95	175
16	1.77	19.94	200
18	1.97	22.33	200
20	1.86	24.17	225
22	1.99	26.44	230
24	1.86	28.27	275
26	1.83	30.26	300

E. Casing accessories include the following:

1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.

2. Expansion Blanket: Elastomeric foam, formed to fit over piping.

3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.

F. Manholes: Black steel with lifting eyes.

1. Finish: Spray-applied urethane, minimum 30 mils thick.

2. Access: 30-inch- diameter waterproof cover with gasket, ladder, and two 6-inch vents, one high and one low, extending above grade with rain caps.

3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.

4. Sump: 12 inches in diameter; 12 inches deep.

5. Floatation Anchor: Oversized bottom keyed into concrete base.

G. Source Quality Control: Factory test carrier pipe to 150 percent of operating pressure of system. Furnish test certificates.

2.3 LOCATOR TAPE

A. Plastic marker tape shall be 5 mil minimum thickness with a solid aluminum core of .35mil minimum thickness and a minimum width of 2". The background of the tape shall be colored based on pipe service with black lettering continuously printed. Marker tape shall have a minimum 35 lbs./inch tensile strength. The installation of the tape shall be at 18 inches below finish grade. Lettering on the tape shall state, "CAUTION: BURIED UTILITY LINE BELOW."

1. Manufacturers: Calpico, Griffoly, Terra Tape or Seton.

2.4 TRACER WIRE:

A. Tracer Wire - All underground piping shall be installed with an extra high-strength, copper clad steel tracer wire including 45 mil HDPE jacket that has a minimum average break load of at least 1150 lbs. The jacket shall be colored based on pipe service, with blue for potable water or green for sewer. Tracer wire gauge shall be 12 AWG, 10 AWG, or 8 AWG depending upon application and installation procedure. This wire shall be continuous and brought up in the valve boxes at the ends of each line segment with splices made only by methods per the equipment manufacturer's recommendation. All miscellaneous splicing components shall be furnished and installed by the Contractor.

2.5 CONCRETE BLOCK ANCHORS

A. Where required, concrete block anchors shall be indicated on coordination drawings. Size of the anchor shall be in accordance with guidelines specified in PPI Handbook.

B. The concrete shall be 4,000 psi, 28-day minimum compressive strength, minimum cement content of 6 sacks per cubic yard, water-cement ratio 0.45 maximum (water content shall include surface water in aggregates), maximum 3/4-inch aggregate, four +/-1-inch slump. Provide 6 percent air content by volume at all exterior slabs.

C. Install anchors at connections to existing systems.

2.6 MECHANICAL SLEEVE SEALS (AT BUILDINGS)

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. Link-Seal.

d. Metraflex Co.

e. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: Interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

a. EPDM (-67 to 200 Deg. F).

3. Install two sleeve seals in a row at each pipe penetration.

4. Pressure Plates: Composite, include two for each sealing element.

5. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements, include one for each sealing element.

2.7 FLOWABLE FILL MIX DESIGN

A. Submit mix design with admixture information for review and approval a minimum of 15 days prior to start of Work.

B. Flowable Fill: Mixture of cement, GranCem, sand, water, and admixtures to produce a flowable fill with a 100-psi maximum, 28-day minimum compressive strength.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Install in accordance with manufacturer’s written installation instructions and these Specifications, including but not limited to unloading and storing of product, field application of factory end seal material for all field cut pipe, trenching with proper attention to required cover height, concrete anchor block construction, laying, fusion welding, field joint insulation procedure, and fitting insulation procedure.

B. Prior to insulating and sealing of joints and fittings the piping system shall be visually and hydrostatically tested.

C. The Contractor shall provide adequate tie-downs or otherwise stage the backfill process to ensure the pipe does not float and create high points.

D. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping to permit valve servicing.

C. Install fittings for changes in direction and branch connections unless bending within pipe limitations is possible.

D. Install piping to allow application of insulation (where not factory insulated).

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

F. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

G. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded hose male connection with cap, at low points in piping system mains and elsewhere as required for system drainage.

H. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

I. Install air vents at high points in piping system.

3.1 EQUIPMENT AND SYSTEMS

A. Pre-engineered systems shall be provided with all straight pipe and fittings factory pre-insulated and prefabricated to job dimensions. Installation drawings shall be provided denoting each piece number and location. Any field verifications or alterations must be approved by the manufacturer. Anchoring and expansion loop sizing as shown on drawings are based on design make. All other manufacturers to submit anchoring and expansion loop details for review with their submittal.

B. All PE-RT pipe and fittings shall be cut, joined, and installed in accordance with the manufacturer’s recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with polyethylene pipe systems.

C. Install locator tape directly above piping, 1 tape per pipe, continuous length of trench.

3.2 TESTING

A. Receipt Inspection: All pipe and fittings shall be subjected to visual inspection at time of delivery and before they are installed or lowered into the trench to be laid. Defective, damaged, or unsound pipe will be rejected.

Cuts, punctures, or gouges that penetrate or reduce the wall thickness by 10% or more are not acceptable and must be removed and discarded. Joints or fittings that do not conform to these specifications will be rejected and must be removed immediately by the Contractor.

B. Hydrostatic Test: A hydrostatic pressure test, as required by project specification, shall be performed at 100 psig for the chilled water and low temperature heating systems and 150 psig for medium temperature hot water heating system, for not less than two hours. The test shall be successful if there is not change in pressure for the two hours. Care shall be taken to insure all trapped air is removed from the system prior to the test. Appropriate safety precautions shall be taken to guard against possible injury to personnel in the event of a failure.

3.3 FUSION AND JOINING

A. FUSION JOINING REQUIREMENTS:

1. All underground piping shall be joined to by the heat fusion process which produces homogeneous, sealed, leak-tight joints. Tie-ins between sections of PE-RT pipe shall be made by butt fusion whenever possible.

2. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per ASTM F3190. A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F2620. Considerations should be given to and provisions made for adverse weather conditions, such as temperatures below freezing, precipitation, or wind, which is accepted by the owner/engineer. The use of a controlled cooling cycle procedure to reduce cooling time is acceptable only as part of a controlled cooling cycle procedure where testing demonstrates that acceptable joints are produced using the controlled cooling cycle procedure.

B. FUSION OPERATORS:

1. The employer of the fusion machine operator is responsible for the fusion joint quality of the fusion weld made by that individual. The employer is responsible for documenting all training and qualification records for that individual, including compliance to any code requirements for fusion/bonder operators.

2. All HDPE fusion equipment operators shall be qualified to the procedure used to perform pipe joining. Fusion equipment operators shall have current, formal training on all fusion equipment employed on the project. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current.

3. For Projects with at least 5,000 feet or with pipe larger than 24 inches, operators or their supervisor must have a current McElroy Fusion Training Certificate for the equipment to be used on the project.

4. When the fusion machine operator is employed by the HDPE pipe and fusion machine supplier, the supplier shall maintain an ISO 9001 Certified Quality Management System.

C. BUTT FUSION EQUIPMENT:

1. For 6" and larger pipe sizes, the pipe butt fusion machine shall be a self-contained hydraulic fusion machine capable of butt fusing HDPE pipe. The carriage must be removable from the chassis for in-ditch use. The machine must be compatible with an electronic data recording device. Accessories will include all butt fusion inserts for the specified range of pipe sizes, a pyrometer kit for checking the surface temperature of the heater, extension cord of appropriate gauge (25' minimum), and hydraulic extension hoses (minimum of four).

2. For 16" and larger pipe sizes, the butt fusion machine shall be capable of autonomously calculating the drag pressure and perform the shift sequence autonomously.

3. In areas where there may be insufficient space for layout of the entire length of fused pipe to be pulled-back, the Contractor shall utilize a continuous PE-RT pipe fusion equipment such as a PolyHorse by McElroy or other means to fuse the length of pipe necessary for the installation.

D. FUSION DATA RECORDING:

1. McElroy DataLogger or equivalent fusion data recorder shall be used to record all fusion welds on hydraulically operated fusion machines. The device shall be capable of meeting the requirements of ASTM F3124, "Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints in Plastic Piping Systems or Fittings".
The device, or combination of devices, shall record the following variables of each fused joint:

a. Heater surface temperature- immediately before inserting the heater plate, measure with a pyrometer and manually enter into the weld record.

b. Gauge pressure during the initial heat cycle

c. Gauge pressure and elapsed time during the heat-soak cycle

d. Heater removal (dwell) time

e. Gauge pressure and elapsed time during the fusing/cool cycle

f. Drag pressure

g. Pipe diameter and wall thickness

h. Type of HDPE material (Specification and Classification) and manufacturer

i. Fusion Machine Identification

2. The device shall record the operator name and a unique operator ID number, along with the date and time of each weld.

3. Records showing the device is up to date on all required calibration should be available for presentation when requested.

4. All fusion welds should be traceable to the report (via operator and weld ID) with an indentation weld stamp or by permanent paint marker/pen next to fusion weld.

5. A weld location map may be requested, prior to commencement of work, by the owner or owner's representative.

E. Mechanical Joint Connection Joining:

1. Contractor shall install mechanical joint connections in accordance with the Manufacturer's recommended procedure and Plastic Pipe Institute (PPI).

2. Butt fuse HDPE MJ (mechanical joint) adapter to HDPE pipe end to connect to a Ductile Iron Mechanical Joint bell using the bolt and gland kit supplied by the HDPE MJ manufacturer.

3. A stainless-steel split ring stiffener shall be added to the inside diameter of the HDPE pipe to ensure proper connection and seal.

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

G. HDPE Bolted Connections: All bolts shall be retorqued 24 hours after initial torquing, then again after the hydrotest.

H. BUTT FUSION EXAMINATION AND TESTING:

1. Examinations

a. Visual: For pipe sections, examine the full exterior circumference for bead uniformity before cutting. After cutting the pipe section, review the interior bead. All beads should have visually acceptable bead formation as shown in Fig 4 and Appendix X2 of ASTM F2620.

In addition, the following characteristics are expected:

1) There shall be no evidence of cracks or incomplete fusing

2) There shall be no evidence of captured objects (e.g., pipe shavings, facer ribbons) between bonded surfaces.

3) Variations in upset bead heights on opposite sides of the cleavage and around the circumference of fused pipe joints are acceptable.

4) The apex of the cleavage between the upset beads of the fused joint shall remain above the base material surface

5) Fused joints shall not display visible angular misalignment, and outside diameter mismatch shall be less than 10% of the nominal wall thickness

6) Fusion data record review that meets criteria of section 3.04.D.1 can be used as additional verification of visual indicators.

b. Fusion Data Record Review

The fusion date record for each fused joint shall be compared to the approved fusion procedure. The reviewer shall verify the following:

1) That all data required by section 3.04.D.1 was recorded

2) Interfacial pressure was within the acceptable range

3) Heater surface temperature was within the acceptable range

4) Butt fusion pressure applied during the fusing/cool cycle was correctly calculated to include drag pressure, fell within the acceptable range for the applicable size and agrees with the recorded hydraulic fusing pressure.

5) Butt fusing pressure was reduced to a value less than or equal to drag pressure at the beginning of the heat soak cycle.

6) Fusing machine was opened at the end of the heat soak cycle, the heater was re-moved, and the end were brought together at the fusion pressure with the accept-able time range

7) Cooling time at butt fusing pressure met the minimum time specified

a) If the recorded data in section 3.04.D.1 is outside the limits of the acceptable range, the joint is unacceptable and must be removed and replaced.

b) Frequency. Records for test fusion joints should be reviewed immediately after the joint is completed. Fusion joints for jobsite fusions should be reviewed daily or before being covered with backfill.

2. Mechanical Tests

a. Contractor shall mechanically test the first fusion of each operator and each machine used on the project. Installation shall not continue until a fusion test has passed the test. Additional mechanical test are not required as long as long as the fusion are reviewed with the frequency specified in section 3.04. E.1.iv. Testing of fusion joints with no fusion data record review shall be at a frequency specified by the Owner or Engineer.

b. The fusion shall be allowed to cool completely, then fusion test straps shall be cut out.

c. All samples shall be labeled with operator information. Testing must be done at 73 degrees F plus or minus 5 degrees. The test temperature and sample size are critical to testing. Testing performed at cold or elevated temperatures may not give similar results to tests performed at ambient temperatures.

d. Each pipe sample weld shall be subjected to testing at two locations 180 degrees apart from each other in the joint weld. All specimens shall be tested by one of the following methods:

1) Reverse Bend Test are allowed for pipe sizes 4” IPS or smaller. The specimens shall be prepared and tested in accordance with ASTM F2620, Appendix X4.

2) Guided Side Bend Test are allowed for all wall thicknesses of 1” or greater. The specimens shall be removed and tested in accordance with ASTM F3183.

3. Hydrostatic Burst Test is allowed for pipe sizes 2”-24”. The specimen length should measure 6 times pipe diameter with the butt fusion joint in the center of the specimen. The specimen should be tested in a tank filled with water, and testing conditions monitored and recorded with computerized equipment.

The specimen will be tested at 4 times pipe rated pressure for 5 minutes with no failure of joint allowed.

a. Results of any mechanical test should be documented. Information on the weld and operator should be transferred from the sample to the testing record.

3.4 INSTALLATION

A. A. DIRECT BURIAL

1. Buried piping and fittings shall be installed per engineering drawings and ASTM D2774, ASTM D2321 and AWWA Manual of Water Supply Practices M55 Chapter 8. The Design Window identified in AWWA M55 Chapter 5 (page 65 of 2006 version) shall be considered acceptable design and installation conditions.

2. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be re-compacted to provide uniform side support for the pipe.

3. Pipe embedment - Embedment material should be Class I, Class II, or Class III materials as defined by ASTM D-2321 Section 6. The use of Class IV or Class V materials is not recommended; however, they may be used only with the evaluation and approval of the engineer at a demonstrated achievable compaction

4. Bedding: Pipe bedding shall be in conformance with ASTM D2321 Section 8. Compaction rates should be as specified in ASTM D2321. Deviations shall be approved by the engineer.

5. Haunching and backfill shall be as specified in ASTM D2321 Section 9 with Class I, II, or III materials. Compaction shall be in excess of 85% Proctor, providing a minimum modulus of 1000 psi or greater.

B. APPURTENANCES

1. All appurtenances (tees, elbows, services, valves, air relief valves, fire hydrants, etc.), must be independently supported and shall not rely on the pipeline and its connections for this support. Excessive stresses may be encountered when appurtenances are inadequately supported.

2. Installation of Tracer Wire. When tracer wire is required, the Contractor shall install along the entire section of pipeline and along all service connections as listed below. The tracer wire shall be installed simultaneously with the polyethylene piping system. Tracer wire shall be installed by the Contractor once backfill has been placed and compacted to at least 12 inches above the top of the pipe and not more than 18 inches above the top of the pipe. Tracer wire shall be properly spliced at each end connection and each service connection. Care should be taken to adequately wrap and protect wire at all splice locations. No bare tracer wire shall be accepted. Provide Magnesium alloy anode for cathodic protection that conforms to the requirements of ASTM B843. Install tracer wire per local and manufacturer's requirements.

3.5 EXCAVATION

A. Excavate trenches in conformance to the plans and drawings and as specified below. Trenchless technologies may be considered with prior approval.

B. Excavate subsoil and unsuitable material.

C. Cut trenches sufficiently wide to enable installation of utility and allow inspection and as shown on details provided on the contract documents.

D. Excavations shall not interfere with normal 45-degree bearing splay of foundations.

E. Correct unauthorized excavation at no cost.

F. Stockpile excavated material in area designated on site and properly remove excess material not being used, from site.

G. During the excavation process, the Contractor shall use caution to detect and shall immediately notify the Engineer if it is believed that the in-place soils have been exposed to or are contaminated with liquid hydrocarbons. At no time shall the proposed HDPE pipe be exposed to liquid hydrocarbons of any fashion.

H. Dewatering:

1. All excavation, construction and backfill of pipes shall be constructed under dry conditions.

2. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining and removing such dewatering systems as are required.

3. The evaluation of the sufficiency of the condition shall be made by the piping manufacturer or its representative and his/her decision shall be binding upon the Contractor.

If the piping manufacturer or its representative determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the piping manufacturer or its representative then agrees with the adequacy of the operating condition.

I. Stability of Temporary Excavations:

1. All excavations shall be in accordance with OSHA requirements.

2. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

3. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

J. Shoring:

1. Except as specified elsewhere, provide all shoring required for earthwork or required as a result of earthwork for safety of workers, existing structures, public or adjacent properties.

2. Provide materials for shoring and bracing in good serviceable condition.

3. Establish requirements for shoring and bracing to comply with local codes and authorities having jurisdiction.

4. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3.6 FOUNDATION AND BEDDING

A. Lay pipe on grade and on a stable foundation. Remove unstable or unsuitable trench bottom soils if present.

B. Refer to contract documents for bedding and trench backfill.

C. Compaction rates should be as specified in ASTM D2321 and the contract documents.

D. Remove excess groundwater from the trench before laying the foundation or bedding and the pipe. Pipe shall be laid when the conditions of trench are dry.

3.7 PIPE CLEANING

A. Before placing the site hot water, chilled water, and geothermal piping system in operation, the piping system shall be thoroughly filled and flushed with clean water twice. Once when the piping is first installed and pressure tested and again prior to equipment startup.

The Contractor shall submit a flushing and purging plan that includes at a minimum the following for review and approval by the owner and design team:

1. Method to fill and prepare the system for flushing.

2. Purging of all air from the system.

3. Equipment selections (filters, tanks, pumps, adaptors, manifolds).

4. Associated pump curves.

5. Sequencing of flushing.

6. Calculations to ensure velocities are achieved in both the mains and all branch laterals.

7. Schematic drawing indicating equipment conditions.

B. This flushing submittal shall be submitted 45 days in advance of the proposed flushing operation to allow adequate time for review by the owner and design team.

C. Pipe flushing shall immediately follow a successful pressure testing of the piping system. Refer to the testing section of this specification for additional information.

D. Flushing Unit:

1. A portable variable flow pumping system with a pump having a minimum capacity of obtaining specified velocities in both directions.

   a. The pumping system shall have flow meters and pressure gauges on both supply and return lines to verify flows during the flushing and purging process. A calibrated electromagnetic flow meter, ultrasonic flow meter, or an orifice flow device that is accurate within 2 percent must be used during the flushing and purging of this system.

   b. The variable-volume pump on the flush/purge unit shall meet or exceed the required flushing flow rates, feet of head required, and minimum velocities to properly flush the system.

2. Storage tank capacity if utilized shall meet the design flow. Tank must be designed to prevent reintroduction of air into the piping system.

3. Filter system shall be capable of removing particles through an initial 50-micron filter or smaller followed by a 5-micron final filter.

4. System fill water metering device shall be accurate within 2 percent to validate flow.

5. Unit is to include different size hose connections and enough hose of ample size and length to meet the flow requirements of the system.

E. Water:

1. The Contractor is responsible for obtaining an adequate supply of potable water as necessary to perform the work as specified herein.

2. All water shall be discharged to the appropriate location(s) in accordance with all state and local applicable laws/standards. This shall be subject to review by the owner and design team.

F. Velocities:

1. Cleaning and flush rates must be at a minimum of 6 ft./sec. through the piping.

2. The maximum flow rate shall not exceed 25 ft./sec, as defined in the Polyethylene Pipe Institute (PPI) handbook. Ensure that maximum velocities do not exceed pressure ratings of the specified piping.

G. Flushing Sequence:

1. Contractor is responsible for purging of the system to ensure no air is present prior to flushing.

2. Provide full-size bypasses for all equipment.

3. Install a full-size bypass on the end of each loop to allow full flow through the system.

4. Begin Flushing Operation:

a. Provide pre-flush of the entire system maintaining minimum velocity in the main distribution piping without exceeding maximum velocity in any of the lateral branch piping.

b. Isolate and flush each lateral branch piping individually.

c. Repeat flushing of each lateral until the entire system is flushed.

d. Isolate lateral branch piping from main distribution.

e. Flush mains maintaining minimum velocity without exceeding maximum velocity in any of the lateral branch piping.

f. Flush entire system maintaining minimum velocity in the main distribution piping without exceeding maximum velocity in any of the lateral branch piping.

g. Repeat as many times as required until water is clear and clean with no debris, including sand, construction material, pipe shavings, or rocks being collected in the system.

h. Final acceptance is required by the owner and design team.

i. Contractor to fill distribution system with potable water, coordinate filling of system with owner/plant operator for any chemical treatment requirements.

j. Coordinate start-up activities, with the construction manager and owner to ensure trouble-free operation of the total system.

k. The building/plant mechanical contractor shall fill, flush, purge, test, and charge the building/plant piping system before opening the distribution system to the building/plant piping system.

l. Document pressures and flow rates for all flushing sequences.

H. Reporting:

1. Document pressures and flow rates for all flushing sequences.

a. Provide time-stamped photos of all pressure gauges and flow meters during each flushing phase, with descriptions outlining the section of piping being flushed.

b. Provide photo documentation of filter screens during each flushing activity.

3.8 TESTING AND LEAKAGE

A. The contractor shall ensure testing can be accomplished in a safe manner, including protection of personnel, equipment, and public in the event of a failure during testing. The contractor shall restrain pipe, components, and test equipment as required. All pumps, valves, temporary connections, meters, gauges and other measuring devices shall be furnished, installed and operated by the Contractor and all such equipment and devices and their installation shall be approved by the Owner’s Engineer.

B. The pressure gauges or data recorders should be calibrated and sufficiently sized to provide mid-range data that result in easy reading and interpretation. Gauges shall be accurate to within 2% of full scale

C. The test pressure may be up to 1.5 times the system design pressure, based on the lowest point in elevation in the test section. The contractor shall ensure that the designated test pressure does not exceed the maximum allowable test pressure specified by the manufacturer for any component in the test section.

D. Test pressures require consideration of thermal conditions. Polyethylene piping materials are typically pressure rated at 73°F (23°C) and PE piping at temperatures greater than 80°F (26°C) require reduced test pressures. (Note that higher pipe temperatures should consider both ambient temperatures and radiant solar heating of exposed black HDPE pipe) Guidance for elevated temperatures can be found in the appendix of Chapter 3 (Material Properties) of the PPI Handbook of PE Pipe.

E. Gravity Pipelines - The Contractor shall perform a low-pressure air test for gravity flow pipelines to the requirements and specifications of ASTM F1417. Warning: All pneumatic test, regardless of pressure, can be dangerous and safety procedures shall be identified, documented, approved by the owner and engineer, and followed.

F. Pressure Pipelines - Pressure testing shall be conducted in accordance with requirements and recommendations of ASTM F2164 (Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydro-static Pressure), AWWA M55 Chapter 9, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition). Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

1. The section of pipe to be tested shall be filled with potable or generally clean water (uncontaminated river/lake water) approved by the Owner/Engineer. While the system is being filled with water, air shall be carefully and completely exhausted.

2. The test procedure for PE-RT pipe consists of two steps: 1) the initial phase or expansion phase and 2) the test phase. During the initial/expansion phase, sufficient make-up water shall be added hourly for 3 hours to return to the test pressure. During the test phase, the expansion phase pressure is reduced by 10 psi to test phase pressure and monitored for at least one hour (3 hours maximum).

3. Under no circumstances shall the total time under test exceed eight (8) hours. If the test is not completed due to leakage, equipment failure or any other reason, depressurize the test section and permit the system to “relax” for eight (8) hours prior to the next testing sequence.

4. In accordance with section 9.8 of ASTM F2164, the pipe shall pass if the final pressure is within 5% of the test phase pressure for the testing period (3 hours maximum). If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.

G. All pressure and leakage testing shall be done in the presence of a representative of the Owner and Engineer.

END OF SECTION 23 20 30

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SECTION 23 21 13 - HYDRONIC 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 pipe and fitting materials and joining methods for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Source-water piping.
   4. Dual Temperature Heating and Cooling Water Piping: 150 psig at 200ºF
   5. Condensate-drain piping.
   6. Air-vent piping.
   7. Safety and relief valve-inlet and -outlet piping.
   8. Dielectric fittings.

B. Related Sections:
   1. 23 05 18 - ESCUTCHEONS FOR HVAC PIPING
   2. 23 05 19 - METERS AND GAUGES FOR HVAC PIPING
   3. 23 07 19 - HVAC PIPING INSULATION

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.
   3. Joining materials.
   4. Chemical treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, 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. Other building services.
   3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

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

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated: Working pressure is equal to the relief pressure plus the static height of the system and pumping head. The only working pressure mandated by authorities having jurisdiction is for makeup water.
1. Hot-Water Heating Piping: 150 psig at 200ºF
2. Chilled-Water Piping: 150 psig 80ºF
3. Source-Water Piping: 150 psig 100°F
4. Dual Temperature Heating and Cooling Water Piping: 150 psig at 200ºF
5. Condensate-Drain Piping: 125ºF
6. Air-Vent Piping: 150ºF
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L

B. Copper Fittings: Soldered fittings, Type L

C. Copper Fittings: Grooved fittings B75, Type L, allowed only in mechanical rooms.

D. DWV Copper Tubing: ASTM B 306, Type DWV.

E. Contractor shall use long radius elbows for all copper piping systems. Use of short radius elbows is allowed, with coordination and approval by the engineer of record, when required for constructability.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade A or B, and schedule number as indicated in Part 3,"Piping Applications" Article.

B. Steel Pipe: ASTM A53/A53M black steel with threaded ends; Grade A or B, and schedule number as indicated in Part 3,"Piping Applications" Article.

C. Steel Fittings: Threaded ASTM A105, wall thickness to match adjoining pipe.

D. Steel Fittings: Welded ASTM A234, wall thickness to match adjoining pipe.

E. Steel Fittings: Grooved ASTM A536, wall thickness to match adjoining pipe. Grooved fittings only allowed in the mechanical room.

F. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

G. Contractor shall use long radius elbows for all steel piping systems. Use of short radius elbows is allowed, with coordination and approval by the engineer of record, when required for constructability.

2.4 PLASTIC (PEX) PIPING

A. Cross-Linked Polyethylene (PEX-a) manufactured in accordance with ASTM F 876, listed to ICC-PMG 1053 and certified by NSF.

B. Rated by the Hydrostatic Stress Board of PPI (Plastics Pipe Institute) at:
1. 160 PSI at 73.4°F
2. 100 PSI at 180°F
3. 80 PSI at 200°F

C. EVOH oxygen barrier to meet DIN 4726.

D. Expansion ratio of 1.1”/10°F per 100’.

E. Bending Radius = 4 times O.D.

F. 30 Year Warranty

G. Pipe to be provided in coil lengths as required for installation.

H. Refer to Section '23 07 19 HVAC PIPING INSULATION' for details on factory applied jacket and insulation.

2.5 PLASTIC (PVC) PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D2665, with wall thickness as indicated in "Piping Applications" Article.
1. PVC Welded Fittings: Solvent welded joints, ASTM D2665 or D2949

2.6 PIPING JOINING MATERIALS

A. 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 otherwise 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

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

E. Solvent Cements for Joining Plastic Piping:
1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
a. PVC solvent cement shall have a VOC content of 510 g/L or less.
b. Adhesive primer shall have a VOC content of 550 g/L or less.
c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.7 TRANSITION FITTINGS
A. Plastic-to-Metal Transition Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

a. Charlotte Pipe and Foundry Company.
b. IPEX Inc.
c. KBI Company.

2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
a. Charlotte Pipe and Foundry Company.
b. IPEX Inc.
c. KBI Company.
d. NIBCO INC.
2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.8 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Charlotte Pipe and Foundry Company.
2. IPEX Inc.
3. KBI Company.

C. Dielectric Unions:
1. Description:
a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used on pipe sizes greater than NPS 2.

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

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Grooved fittings allowed only in mechanical rooms.

B. Hot-water heating, chilled water, and dual temperature piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, copper fittings, soldered joints.
2. Schedule 40, Grade A or B, ASTM A53 (E or S) or ASTM A106; Class 150, steel fittings; threaded joints.

C. Hot-water heating, chilled water, and dual temperature piping, aboveground, NPS 2-1/2 and larger, shall be the following:
1. Schedule 40, Grade A or B, ASTM A53 (E or S) or ASTM A106; Class 150, steel fittings; welded joints.

D. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, copper or copper alloy fittings, soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

E. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

G. Hot-water Snow melt piping, above and below ground
1. Plastic (PEX-a) Piping.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install long radius elbows wherever they fit.

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

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

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

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

3.3 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE JOINT CONSTRUCTION

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

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

C. 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.

D. 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.

E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

F. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
3. PVC Non-pressure Piping: Join according to ASTM D 2855.

3.5 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Buffer Tanks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:
1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
a. NIBCO
b. Watts
c. Apollo
d. RWV
2. Body: Cast-iron or steel body, ball, butterfly, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Stainless steel.

4. Stem Seals: EPDM O-rings.
5. Disc: Glass- and carbon filled PTFE.
6. Seat: PTFE.
7. End Connections: Threaded or socket.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250ºF.

B. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
   a. NIBCO
   b. Watts
   c. Apollo
   d. RWV
2. Body: Bronze or brass.
3. Disc: EPDM
4. Seat: Steel
5. Steam Seals: EPDM O-rings.
6. Diaphragm: EPDM.
7. Low inlet-pressure check valve.
8. Wetted, Internal Working Parts: Stainless steel and rubber.
9. Inlet Strainer: Removable without system shutdown.
10. Valve Seat and Stem: Noncorrosive.
11. Valve Size and Capacity: As indicated on Drawings.
12. Operating Pressure: Factory set and field adjustable.

C. Diaphragm-Operated Pressure Relief Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
   a. NIBCO
   b. Watts
   c. Apollo
   d. RWV
2. Body: Bronze or brass.
3. Disc: EPDM.
4. Seat: Steel.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Stainless steel and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

11. Alarm: Valve to be interoperable with the BACnet Building Management System. Valve to provide an alarm when it opens.

D. Automatic Flow-Control Valves:
1. Body: Brass or ferrous metal.
2. Flow Control Assembly, provide either of the following:
a. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
b. Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within 2- to 80-psig differential pressure.
3. Combination Assemblies: Include bonze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow within plus or minus 10 percent regardless of system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200ºF.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225ºF.

B. Automatic Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240ºF.

C. Bladder-Type ASME Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
a. American Wheatley
b. Armstrong
c. TACO

2. Tank: Welded steel, rated for 125-psig working pressure and 375ºF maximum operating temperature. Tanks shall be factory tested after taps are fabricated and supports installed and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Size: See schedules.

D. Diaphragm-Type ASME Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
   a. American Wheatley
   b. Armstrong
   c. TACO
2. Tank: Welded steel, rated for 125-psig working pressure and 375ºF maximum operating temperature. Tanks shall be factory tested after taps are fabricated and supports installed and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Size: See schedules.

E. Coalescing-Type Air and Dirt Separators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
   a. American Wheatley
   b. Armstrong
   c. TACO
2. Tank: Fbaricated steel tank; ASME constructed and stamped for 125 psig working pressure and 270 deg F maximum operating temperature.
3. Coalescing Medium: Stainless steel
4. Air Vent: Threaded to top of separator.
5. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded to bottom of separator.
7. Size: See schedules.

2.3 STRAINERS

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

2.4 BUFFER TANKS

A. Source Water Buffer Tank:
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
a. American Wheatley
b. Armstrong
c. TACO
2. Tank: Welded steel, rated for 125-psig working pressure and 375ºF maximum operating temperature. Tanks shall be factory tested after taps are fabricated and supports installed and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Connections: Provide with flanged 8” inlet and outlet connections.
4. Drain: Provide with drain and drain valve.
5. Provide with anchor clips as required for installation.
6. Size: See schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Examine threads on all devices for form and cleanliness.
C. 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.

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
B. Install calibrated-orifice, balancing valves at each branch connection to return main.
C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal, unless that terminal is control by an electronic pressure independent control valve (ePIV).

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at high points of system piping in mechanical equipment rooms only.
   1. Provide air outlet drain line full size of air outlet to floor drain.
B. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
C. Install air separators in pump suction. Install blowdown piping with gate or full-port ball valve full size of separator outlet; extend full size to nearest floor drain.
D. Install bladder-type expansion tanks on the floor.
E. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 23 21 16

SECTION 23 21 23 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Split-coupled, Vertical Inline Twin ‘Dual Arm’ Centrifugal Pumps.
   2. Wet-rotor pumps.
   3. Pump Specialty Fittings

1.2 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. FKM: Fluoroelastomer polymer.

D. HI: Hydraulic Institute.

E. NBR: Nitrile rubber or Buna-N.

F. ANSI – American National Standards Institute.

G. OSHA - Occupational Safety & Health Administration.

H. ASHRAE – American Society of Heating, Refrigeration and Air-Conditioning Engineers.

I. NEMA – National Electrical Manufacturers Association.

J. UL – Underwriters Laboratories.

K. ETL – Electrical Testing Laboratories.

L. CSA – Canadian Standards Association.

M. NEC – National Electric Codes.

N. ISO – International Standards Organization.

O. IEC – International Electrotechnical Commission.

P. ASME – American Society of Mechanical Engineers.

1.3 RELATED SECTIONS

A. 23 07 19 - HVAC PIPING INSULATION

B. 23 21 16 - HYDRONIC PIPING SPECIALTIES

C. 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

D. 23 07 19 - HVAC PIPING INSULATION

E. 23 07 16 - HVAC EQUIPMENT INSULATION

F. 23 05 19 - METERS AND GAUGES FOR HVAC PIPING

G. 23 05 23.14 - CHECK VALVES FOR HVAC PIPING

H. 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

I. SECTION 26

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump.
   1. Detail weighted average pump efficiency-Part Load Efficiency Value (PLEV) – Pump Rating Report shall be submitted for each pump. Pump PLEV Shall be based on the standard load profile developed in AHRI 550/590 also known as IPLV or integrated part load value. Pump PLEV rating shall be based on points at 100%, 75%, 50%, 25%
   2. Includes certified performance curves and rated capacities of selected models, weights, furnished specialties and accessories. Indicate pump operating point on curve.
   3. Submittal must be specific to this project.

B. Shop Drawings: For each pump. Show pump and control enclosure dimensions on shop drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE
   1. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.
   2. Ensure pump operation, at specified system fluid temperatures without vapor binding and cavitation, is non-overloading in parallel or individual operation, and operates to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

3. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed but not less than specified
4. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of 20 years experience.
5. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. New pump start-up shall be for the purpose of determining pump alignment, lubrication, voltage, and amperage readings. All proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head, if required.
6. A copy of the start-up report shall be made and sent to both the contractor and to the Engineer.
7. The pump and controls shall be integrated by the manufacturer in the factory, including assembly, wiring, programming and testing. Sensorless data, for all suitable pumping unit, shall be mapped in the integrated controls using tested performance measurements for each specific pump. Actual flow reading on site is to be available digitally for the BMS and on the controls local keypad. The use of catalog data for Sensorless data mapping will not be acceptable..
8. The complete pump and control package shall be Underwriter's Laboratories listed and carry UL778 approval.

1.7 DELIVERY STORAGE AND HANDLING

1. Deliver materials and components in manufacturer's original packaging with identification labels intact and in sizes to suit project. Deliver materials in such a matter as to protect the materials from shipping and handling damage. Include manufacturer's name, job number, pump location and pump model and serial numbers on identification labels.
2. Use all means necessary to protect equipment before, during and after installation.
3. All scratched, dented and otherwise damaged units shall be repaired or replaced as directed by the Engineer.
4. Leave pump port protection plates in place until pumps are ready to connect to piping.

1.8 WARRANTY

1. Provide a manufacturer's warranty with a period 18 months from date of shipment or 12 months from date of installation.

1.9 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
   1. Include installation instructions, assembly views, lubrication instructions and replacement parts list.

PART 2 - PRODUCTS

2.1 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.
   1. Component Importance Factor: 1.0.

B. Test reports
   1. Submit test reports with each pump showing compliance with specified performance characteristics and physical properties including structural and vibration performance while still in the test rig piping.
   2. Test reports shall also detail the accuracy of the controls flow and head readout, compared with the rest rig calibrated instruments.

2.2 SPLIT-COUPLED, VERTICAL TWIN INLINE 'DUAL ARM' PUMPS

A. Basis of Design: Armstrong.

B. Available manufacturers offering products that may be incorporated into the Work include the following:
   1. Bell and Gossett
   2. Grundfoss

C. Description: Contractor shall furnish and install new split-coupled vertical inline twin pumps for the hydronic systems as indicated on the drawings. Pumps shall have integrated intelligent controls. Pumps shall meet types, sizes, capacities and characteristics as scheduled on the equipment drawings.
   1. The inlet and outlet ports on the casing shall be one size larger than the single size pump size, so that both units may operate in parallel for double single pump flow rate with no loss of single pump efficiency.
   2. Each port shall be fitted with an isolation valve that allow the units to operate in parallel or duty / standby, and may also be used to isolate one pumping unit for servicing / removal with the other pump still operating.
   3. Include casing drain plug at the lowest point in the casing.

D. Components
   1. Volute/Casing
      a. Shall be ASTM A48, Class 30B cast iron or ASTM A536 ductile iron.
      b. Shall be radially split to allow for removal of rotating elements without disturbing piping connections.
      c. Shall have taps for gauge ports on both suction and discharge connections
   2. Flapper Valve
      a. Shall be self balancing.
      b. Shall be 316 stainless steel with EPDM gasket.
      c. Shall be mounted into the pump volute using self-sealing bolts.
   3. Pump Shafts
      a. Split-coupled: Steel motor shaft with non-ferrous shaft sleeve, integral to motor. Stainless steel to be ASTM A276, type 316. Provide with shaft grounding rings.
   4. Impeller

a. Stainless steel or ASTM B584 bronze. Impellers shall be hydraulically balanced to ANSI G6.3.
b. Shall be keyed to the shaft and secured by a stainless-steel locking cap screw or nut.

5. Coupling
   a. Rigid spacer type, high tensile aluminum
   b. Shall be provided with an OSHA Compliant coupling guard
6. Motor
   a. NEMA Premium Motor per ANSI/NEMA MG 1
   b. Heavy duty grease lubricated ball bearings.
   c. Motor shall be non-overloading over the entire pump curve
7. Flanges
   a. ANSI/ASME B16.5, Class 150

E. Pump motor and controls protection
1. Include protection as follows:
   a. Motor phase to phase fault.
   b. Motor phase to ground fault.
   c. Loss of supply phase.
   d. Over voltage.
   e. Under voltage.
   f. Motor over temperature.
   g. Inverter overload.
   h. Over current

F. Integrated VFD with pump control
1. VFD to be compatible with BACnet IP.
2. Integrated with UL Type 12 minimum enclosure rating, sensorless controls complete with fused disconnect switch and menu driven graphical keypad interface.
3. Pumps to be controlled based on flow or holding of a differential pressure per controls drawings.
4. Integrated pump controllers shall provide near unity displacement power factor (cos Ø) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.
   a. Integrated pump controls shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.
   b. Integrated Pump Controllers shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements
5. Integrated pump controls shall support direct communication with the building management system with built-in support for BACnet controllers.
6. Coordinate rotation of VFD/Control interface to provide a minimum 3’ of clearance between the screen and any obstructions. Screens to be rotated in the factory.
7. Include energy monitoring function to ASHRAE 189.1P.
8. Controllers shall be capable of maintaining flow rate data.
9. Controller shall operate under quadratic pressure control mode.

a. Ensure head reduction with reducing flow conforms to quadratic control curve.
b. Head at zero flow: 40 % minimum of design duty head.
c. Linear or Proportional Pressure Control without sensor is unacceptable.
d. Ensure control mode setting and minimum/maximum head setpoints are user adjustable using built-in programming interface.
e. Ensure integrated control software is capable of controlling pump performance for non-overloading power at every point of operation.
f. Ensure integrated control software is capable of flow rate display and data output of ± 5% accuracy to BAS/BMS.
g. Ensure the controls can displayed and digitally transmit real-time flow & head values

2.3 WET-ROTOR PUMPS

A. Basis of Design: Armstrong.

B. Available manufacturers offering products that may be incorporated into the Work include the following:
1. Bell and Gossett
2. Grundfos

C. Description: Factory-assembled and -tested, wet-rotor pump. Pump and motor to form an integral unit with bearings lubricated by the pumped liquid.

D. Pump Construction:
1. Body: Type 304 stainless steel.
2. Impeller: Type 304 stainless steel.
3. Pump Shaft: AISI 420 Stainless steel.
4. Bearings: Carbon Sleeve.

E. Motor: Variable speed.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
a. Efficiency: Premium Efficiency.
b. NEMA Design: 1.
c. Service Factor: 1.15.
3. ECM

F. Capacities and Characteristics:
1. See Schedule.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch.
4. Type 304 stainless steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

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

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, flapper valves and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping. Ensure that the pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.

D. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.
1. Comply with requirements for restraint devices specified in Section 230548.13 "Vibration Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
3. Ensure no pipe strain is imposed on pump flanges.

3.2 ALIGNMENT

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

B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.

C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

D. Comply with pump and coupling manufacturers' written instructions.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 PIPING CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps, ensuing pipes are aligned and square to pump flanges. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

C. Install check valve and shut off valve on discharge side of pumps.

D. Install suction diffuser and shutoff valve on suction side of pumps.
   1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

E. Install pressure and temperature gauges on pump suction and discharge as indicated.

F. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

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

3.6 STARTUP SERVICE

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

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 FIELD QUALITY CONTROL

A. Have manufacturer review work involved in handling, installation, protection and cleaning of hydronic pumps and components, and submit written reports in acceptable format to verify compliance of work to contract conditions.

B. Perform tests and inspections with the assistance of a factory-authorized service representative, performing test and inspections as required by factory-authorized service representative and manufacturer.

C. Hydronic pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports upon the delivery of the pumps, when preparatory work to install the pumps is complete and upon completion of the installation. The factory-authorized service representative shall be involved in reviewing and creating the test and inspection reports.

3.8 DEMONSTRATION

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

END OF SECTION 23 21 23

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Copper tube and fittings.
2. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Copper tube and fittings.

B. Product Data Submittals: For each product.
1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Shop Drawings:
1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For each welder performing shop or field welding on Project.

B. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Prepare valves and specialties for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads and other end connections.

C. Use the following precautions during storage:
   1. Maintain valve and specialty end protection.
   2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASHRAE 15.

B. Comply with ASME B31.5.

C. Test Pressure for Refrigerant R-410A:
   1. Suction Tubing for Heat-Pump Applications: 535 psig.
   2. Hot-Gas and Tubing Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B280, Type ACR.

B. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

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

D. Brazing Filler Metals: AWS A5.8M/A5.8.

2.3 REFRIGERANTS

A. R-454B, ASHRAE 34: Tetrafluoropropene/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Refrigerant: R-454B

B. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 4 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install valve and refrigerant specialties per manufacturers recommendations.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping in accordance with ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

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

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

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

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

O. Slope refrigerant piping as follows:
   1. Install per manufacturers recommendations to ensure proper oil return to the compressor.
   2. Install traps and double risers to entrain oil in vertical runs.
   3. Liquid lines may be installed level.

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

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

R. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."
   1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for restraints in Section 230548.13 "Vibration Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. (6 m) long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 ft. (6 m) or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. (6 m) or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

C. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. 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.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

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

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

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

D. Perform the following adjustments before operating the refrigeration system, in accordance with manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves but not bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following HVAC water-treatment systems:
   1. Automatic chemical-feed equipment and controls.
   2. Chemicals.
   3. Inhibited propylene glycol.
   4. Filters, bag type (side stream filter).
   5. Corrosion coupon racks

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Pretreatment equipment and chemical- treatment equipment, showing tanks, maintenance space required, and piping connections to HVAC systems.

1.3 INFORMATIONAL SUBMITTALS

A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Field quality-control reports.

C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

D. Water Analysis: Illustrate water quality available at Project site.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Upon every system fill, contractor shall measure and record the total volume of water and glycol required to fill the system.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems as indicated in this Specification. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including glycol heating and glycol cooling shall have the following water quality items within spec to meet equipment manufacturers requirements:
   1. pH: Maintain a value within equipment manufacturers limits.
   2. Alkalinity: Maintain a value within equipment manufacturers limits.
   3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion.
   4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion.
   5. Scale Control: Provide softened water for initial fill and makeup.
   6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.

2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Chemical Solution Tanks:
   1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
   2. Molded cover with recess for mounting pump.
   3. Capacity: 55 gallon.

B. Chemical Solution Injection Pumps:
   1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
   2. Adjustable flow rate.
   3. Metal and thermoplastic construction.
   4. Built-in relief valve.
   5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
   6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

2.4 INHIBITED PROPYLENE GLYCOL

A. Inhibited Propylene Glycol:
   1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
   2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
   3. Operating Temperature Range: minus 50 deg F to 250 deg F.
   4. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
   5. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to minus 20 deg F. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
   6. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

2.5 FILTERS, BAG TYPE

A. Basis of Design: Wessels Co.
   1. Available manufacturers offering products that may be incorporated into the Work include the following:
      a. PRM Filtration
      b. Watts

B. Description: Floor-mounted housing with filter bags for removing particles from water.
   1. Housing: Corrosion resistant 316 Stainless steel; designed to separate inlet from outlet and to direct inlet through bag-type water filter; with bag support and base, feet or skirt.
      a. Pipe connections NPS and Smaller: Threaded in accordance with ASME B1.20.1.
      b. Provide with a sight flow indicate to allow verification of flow through filter.
   2. Bag, Replaceable: Of shape to fit housing.
      a. Material: Polypropylene
      b. Rating: 5 microns
      c. Polyproplyene ring with handle for easy removal.
      d. FDA / USP Material Safety Compliant

C. Capacities and Characteristics: Side stream filter to clean a maximum of 5% of related systems design flow.
   1. See schedule.

2.6 CORROSION COUPON RACK

A. Basis of Design: NALCO.

1. Available manufacturers offering products that may be incorporated into the Work include the following:
   a. Novatech
   b. Cannon Water

B. Description: wall or board mounted corrision coupon rack, used for monitoring corrosion rates, scale formation and erosion of various different materials in the hydronic system.
   1. Designed to ASTM Specifications
   2. Rated to 150 psi at 140°F
   3. 4 station rack, one for mild steel, copper, stainless steel and aluminum.
   4. ¾" schedule 80 PVC, pre-assembled, and mounted on a ½" PE backboard or wall.
   5. Inlet/outlet ball valves shall be included for easy bypass and coupon change-outs

C. Accessories:
   1. Provide with an inlet flow control valve.
   2. Provide with a flow meter.
   3. Provide with a strainer.
   4. Provide with inlet/outlet ball valves shall be included for easy bypass and coupon change-outs

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.

B. Install water-testing equipment on wall near water-chemical-application equipment.

C. Install interconnecting control wiring for chemical-treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including glycol heating, and glycol cooling, and equip with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   2. Install water meter in makeup-water supply.
   3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.

4. Install a swing check on inlet after the isolation valve.

F. Install automatic fluid make-up equipment for glycol water system and include the following:
1. Chemical solution tanks.
2. Chemical solution injection pumps.
3. Water meter in makeup supply to system.
4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

G. Install side stream filters across associated pump inlet and outlet.

H. Side stream filters to be floor mounted and installed in a manner to allow for easy access for filter replacement. Mount side stream filters on support legs shipped with the unit. Support legs to be bolted to the ground with anchor bolts.

I. Side stream filters to have at least five pipe diameters of inlet/outlet pipe connection to provide minimal turbulence and enhance performance.

J. Install pressure gauges at both the inlet and outlet of the separator in order to monitor pressure loss.

K. Prior to installation of all equipment, inspect the inlet/outlet/purge connections for foreign objects inserted during shipping/storage. Proper purge hardware and/or solids-handling equipment is required to flush separated solids from the separator.

L. Install corrosion coupon rack in a horizontal orientation. Water should always flow from the bottom and exit at the top. Run a pipe that matches the coupon rack piping size to and from the hydronic system. Water should always be passing over the corrosion test sample starting at the holder screw. Test samples shall be installed starting with the least noble alloy and finishing with the most noble alloy according to galvanic corrosion chart. Install rack and coupons per manufacture’s recommendations.
1. 1st Coupon Aluminum
2. 2nd Coupon Mild Steel
3. 3rd Coupon Copper
4. 4th Coupon Stainless Steel

3.3 SYSTEM FLUSH

A. Coordinate system flush with water treatment vendor.

B. Contractor shall open all valves and provide temporary strainers at pump, heat exchanger, heat pump and other equipment inlets with a minimum mesh of 30.

C. Contractor to ensure strainers, air and dirt separators, and drains are accessible before system flush.

D. Contractor shall perform a system flush, running water a minimum of 5 feet per second throughout the hydronic systems. Contractor shall maintain the velocity until the system discharge is clear of debris. Contractor shall flush both the new hydronic systems and the existing boiler system.

E. After the system discharge runs clear, contractor shall remove temporary strainers and clean them. If temporary strainers are removed and contain debris, the system flush shall occur again.

F. Once temporary strainers are free of debris, contractor shall provide permanent strainer filters and begin the system fill process. Contractor shall communicate with photographs clear and clean temporary strainers before moving to the system fill process.

3.4 SYSTEM FILL

A. Coordinate system fill with water treatment vendor.

B. Do not fill hydronic systems until piping is completely installed and debris has been flushed and removed from the system to the fullest extent possible. Flushing shall occur for the existing to remain boiler to remove any debris. Contractor to ensure strainers, air and dirt separators, and drains are accessible before fill.

C. Notify the Engineer of Record, the Owner, and the Water Treatment Vendor at least 48 hours prior to the initial fill.

D. Upon initial system fill, measure total fluid volume required to fill system. During system fill, contractor shall vent air at the highest point of all hydronic loops. Coordinate system pressure and flow requirements with the heat pump vendor and the engineer of record. The system shall run for 4 hours before addition of any chemicals, cleaners.

E. At the conclusion of the system fill the entire system shall be:
   1. Tested (pH, scale, sediments, corrosion inhibitor PPM, iron levels, total hardness, microbiological limits)
   2. Treated depending on the results of the test
   3. The entire system shall have pumps running for 24-48 hours until system pressures stabilize.

F. Provide water treatment reports containing pH, sediment levels, scale levels, etc… at the end of system fill. If water treatment reports are deemed unsatisfactory after engineer and owner review, contractor shall work with the water treatment vendor to provide more cleaners, chemicals or if required further system fills until water treatment report is satisfactory.

3.5 PIPING 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 equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.12 "Ball Valves for HVAC Piping," and Section 230523.13 "Butterfly Valves for HVAC Piping"

E. See Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Water Tests shall be performed with an approved chain of custody system in place. The chain of custody shall include the initial tester, the final lab testing professionals, and all intermediaries.

C. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

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

E. Prepare test and inspection reports.

F. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report, advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at eight-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

G. At eight-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

H. Comply with ASTM D3370 and with the following standards:
1. Silica: ASTM D859.
2. Acidity and Alkalinity: ASTM D1067.
3. Iron: ASTM D1068.
4. Water Hardness: ASTM D1126.

3.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping and heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 23 25 00

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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

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

B. Related Sections:
1. Section 23 05 93, "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DUCT DIMENSIONS

A. Duct dimensions shown on the drawings are nominal sizes for inner wall dimensions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives
2. Sealants and gaskets.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes. Indicate where actual duct size is increased to accommodate liner.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal: For metal duct hangers and supports, submittals shall include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS.

A. Duct Performance: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

C. Delegated Design for Structural Performance: Engage a qualified professional engineer to design metal duct hangers and supports. The professional engineer must confirm that the capacity of the existing structure is adequate where it will be used to support duct. Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible". Make specific note of ductwork requirements at large aspect ratios. Duct work running from the basement of the building to the first floor in existing to remain shafts have aspect ratios from 4:1 to 6:1. Contractor shall ensure these ducts remain structurally sound under gravity loads and stresses during operation per SMACNA standards.
a. Professional Engineering Qualifications: A professional engineer who is legally qualified to practice in New York State and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of systems or assemblies that are similar to those indicated for this Project in material, design, and extent.

D. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

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

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Transverse joints for ductwork rated 3” W.G. and greater shall be made with Ductmate, Ward or Nexus connections.

C. Longitudinal Seams: Longitudinal seams to shall be made with a Pittsburg Lock (Type L-1). Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. All mitered elbows shall be provided with double-wall airfoil style turning vanes as specified in section 23 33 00,”Air Duct Accessories”.
   2. All branch connections to be 45 degree takeoffs or conical taps.

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of galvanized sheet steel unless otherwise indicated.
   2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Lindab Inc.
      b. SEMCO Incorporated.
      c. Sheet Metal Connectors, Inc.
   3. Pleated, adjustable and mitered elbows shall not be permitted. Segmented elbows shall be specified with a minimum of five segments.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
   2. Draw band and crimp type transverse joints (RT-3 and RT-5 respectively) shall not be permitted.
   3. Pleated, adjustable and mitered elbows shall not be permitted. Segmented elbows shall be specified with a minimum of five segments.

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

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

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

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View and to be Painted: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

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.

2.5 ACOUSTIC DUCT LINER

A. Polyolefin Duct Liner: Cross-linked, partially open-cell polyolefin foam sheet or roll materials, with reinforced aluminum foil facing and adhesive backing, sheet (Type II) complying with ASTM C1427.
   1. Foam Core Density: 7.5 lb/cuft.
   2. Minimum Noise Reduction Coefficient (NRC): 0.75 for 1-inch thickness.
   3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
   4. Liner Adhesive: As recommended by insulation manufacturer.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
   2. 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.

3. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
4. Butt transverse joints without gaps, and coat joint with adhesive.
5. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
6. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

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

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

C. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

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

2.7 HANGERS AND SUPPORTS

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

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

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

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

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

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

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

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

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

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

C. Install ducts with fewest possible joints.

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

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

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

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

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

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

J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

L. Elbows: Use long-radius elbows wherever they fit.
   1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
   2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.

3.2 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

C. All ducts exposed to view are to be constructed of stainless steel as per "Duct Schedule" Article. All ducts concealed from view are to be carbon steel as per "Duct Schedule" Article.

D. All joints are to be welded and are to be telescoping, bell, or flange joint as per NFPA 96.

E. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

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

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch trapped copper drain from each drain pocket to open site floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.4 DUCT SEALING

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

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

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

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

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

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

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

3.7 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
   2. Indoor exposed Type I Kitchen exhaust duct to be fabricated from stainless steel with a brushed finish.
   3. Indoor concealed Type 1 Kitchen exhaust duct to be black steel.
   4. Indoor concealed Type II Kitchen exhaust duct to be either welded aluminum or stainless steel.

B. Supply Ducts:
   1. Ducts Connected to Fan Coil Units, VAV Reheat Boxes, Flow Control Boxes and Active Chilled Beams:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 4.
   2. Ducts Connected to Variable-Volume AHU/DOAS:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 4.
   3. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 4.

C. Return Ducts:
   1. Ducts Connected to Fan Coil Units, VAV Reheat Boxes, Flow Control Boxes and Active Chilled Beams:
      a. Pressure Class: Positive or negative 2-inch wg.
      b. Minimum SMACNA Seal Class: B.
   2. Ducts Connected to AHU/DOAS:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.

3. Ducts Connected to Equipment Not Listed above:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
2. Ducts Connected to AHU/DOAS:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and B if positive pressure.
3. Ducts Connected to Equipment Not Listed above:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure; A if positive pressure.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Fan Coil Units, VAV Reheat Boxes, Flow Control Boxes and Active Chilled Beams:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.
2. Ducts Connected to AHU/DOAS:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.
3. Ducts Connected to Equipment Not Listed Above:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.

F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

3.9 DUCT FITTINGS:

A. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Velocity 1,000 fpm or Lower:
1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.
b. Velocity 1,000 to 1,500 fpm :
1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1,500 fpm or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1,000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1,000 to 1,500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1,500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

END OF SECTION 23 31 13

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Iris manual volume dampers.
2. Control dampers.
3. Combination fire and smoke dampers.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Duct accessory hardware.
8. Duct silencers

B. Related Requirements:
1. Section 23 33 46 “Flexible Ducts” for insulated and non-insulated flexible ducts.
2. Section 23 37 23 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
3. Section 28 46 21.11 "Addressable Fire-Alarm Systems" for duct-mounted fire and smoke detectors.
4. Section 28 46 21.13 "Conventional Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

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.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4, brushed finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 IRIS MANUAL VOLUME DAMPERS

A. Iris, Galvanized, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
      b. Continental Fan.
      c. Fantech.
      d. ISC .
   2. General:
      a. Airflow measurement taps shall be provided with airflow adjustment charts located on the damper for convenient airflow measurement and control. Damper shall be capable of controlling airflow to +/-5% of design flow in a straight duct.
      b. Damper position shall be set with the factory supplied spanner wrench, with no zero-calibration required. Dampers requiring zero calibration are not acceptable.
      c. Provide manufacturer recommended straight lengths of duct to the inlet and outlet of the damper for accurate balancing.
   3. Leakage:
      a. Leakage shall not exceed 6 cfm/sq. ft. against 1-inch wg differential static pressure.

4. Suitable for horizontal or vertical applications.
5. Frames:
   a. Duct connections shall be gasketed and beaded to provide for a sealed duct connection. The gasket shall be a fitted EPDM gasket.
6. Blades:
   a. Galvanized-steel, 22 gauge.
   b. Blades shall be fully retractable.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   1. Carnes Company.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Pottorff.
   5. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. General Requirements:
   1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
   2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:
   1. AMCA Certification: Test and rate in accordance with AMCA 511.
   2. Leakage:
      a. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
   3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
   4. Velocity: Up to 3000 fpm.
   5. Temperature: Minus 25 to plus 180 deg F.
   6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:
   1. Linkage out of airstream.
   2. Suitable for horizontal or vertical airflow applications.
   3. Frames:
      a. Hat, U, or angle shaped.
      b. 0.08-inch- thick extruded aluminum.
      c. Mitered and welded corners.
      d. Flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Hat, U, or angle shaped.
      b. 0.08-inch- thick extruded aluminum.

c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blade Edging Seals
   a. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; stainless steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
   a. Oil-impregnated stainless steel sleeve.
   b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

E. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 115 V, 60 Hz, 1PH or 24V, 60 Hz.

2.5 COMBINATION FIRE AND SMOKER DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Carnes Company.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.
5. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. Combination fire and smoke dampers to be UL555 / UL555S listed.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire rating: 2 or 1 hour, refer to architects' life safety plan. Confirm all combination fire and smoke damper ratings with engineer of record before installation.

E. Performance
1. AMCA Certification: Test and rate in accordance with AMCE Publication 511.
2. Leakage:
   a. Class IA: Leakage shall not exceed 2 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm (15 m/s).
5. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

F. Construction:
   1. Suitable or horizontal or vertical airflow applications.
   2. Linkage out of airstream.
   3. Frame:
      a. Hat shaped.
      b. Galvanized sheet steel, with mechanically attached corners and mounting flange.
      c. Gauge is to be in accordance with UL listing.
   4. Blades:
      a. Roll-formed, horizontal, v-groove, galvanized sheet steel.
      b. Maximum width and gauge in accordance with UL listing.
   5. Blade Edging Seals:
      a. Silicone rubber.
   6. Blade Jamb Seal: Flexible stainless steel, compression type.
   7. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
   8. Bearings:
      a. Oil-impregnated bronze or Oil-impregnated stainless steel sleeve.

G. Mounting Sleeve:
   1. Factory installed, galvanized sheet steel.
   2. Length to suit wall or floor application with factory-furnished silicone caulking.
   3. Gauge in accordance with UL listing.

H. Heat Responsive Device:
   1. Replaceable, 165 deg F rated, fusible links.

2.6 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

C. Vane Construction: Single wall for ducts up to 36” wide, double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Access Doors Larger than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   1. CL WARD & Family Inc.
   2. Ductmate Industries, Inc; a DMI company.
   3. Duro Dyne Inc.
   4. Ventfabrics, Inc.
   5. Ward Industries; a brand of Hart & Cooley, LLC.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. 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 200ºF.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250ºF.

2.9 DUCT SILENCERS

A. General Requirements:

1. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on drawings. all silencers shall be factory fabricated and supplied by the same manufacturer.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

B. Rectangular Silencers:
1. Rectangular straight silencers shall have with splitters or baffles to achieve the specified performance. Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, 22 gauge.

C. Rectangular Elbow Silencers:
1. Rectangular elbow silencers shall have acoustical splitters that are internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, 18 gauge.

D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G60 galvanized sheet steel, 0.034 inch.

E. Connection Sizes:
1. See schedules and drawings, match connected ductwork.

F. Principal Sound-Absorbing Mechanism:
1. Principal sound-absorbing mechanism shall be acoustic media. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: Flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

H. Accessories:
1. Factory installed end caps to prevent damage, contamination during shipping.

I. Source Quality Control:
   1. Test in accordance with ASTM E477.
   2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
   3. Leak Test: Test units for airtightness at 100 percent of associated fan static pressure.

J. Capacities and Characteristics:
   1. See schedules.

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 Pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. Control devices requiring inspection.
   8. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 33 46 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Insulated Flexible Ducts.
2. Flexible Duct Connections.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

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. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

C. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

D. Product materials shall have a flame-spread index of 25 or less and a smoke-developed index of 50 or less.

2.2 INSULATED FLEXIBLE DUCTS

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. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, LLC.

B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160ºF.
   4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts directly. Do not use flexible ducts to change directions.

D. Connect diffusers or light troffer boots to ducts with maximum 36-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:
   1. Install ducts fully extended.
   2. Do not bend ducts across sharp corners.
   3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
   4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
   5. Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:
   1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 24 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
   2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.

3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 23 33 46

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SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fans, centrifugal, inline - square.
2. Ventilators, centrifugal - roof-mounted downblast.
3. Ventilators, centrifugal - roof-mounted upblast.
4. Fans, propeller - sidewall mounted.

1.2 ACTION SUBMITTALS

A. Product Data:
1. For each type of product.
a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
b. Rated capacities, furnished specialties, and accessories for each fan.
c. Fans:
1) Certified fan performance curves with system operating conditions indicated.
2) Certified fan sound-power ratings.
3) Fan construction and accessories.
4) Motor ratings and electrical characteristics, plus motor and electrical accessories.
5) Fan speed controllers.
d. Material thickness and finishes, including color charts.
e. 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 for designing vibration isolation bases.
5. 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.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing fan rooms and fan system layouts, reflected ceiling plans, and other drawings required to illustrate 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. Startup service reports.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans and ventilators, include the following:
1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective coverage for storage and identified with labels describing contents.
1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. UL Compliance: Exhaust fans to be UL rated.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.2 FANS, CENTRIFUGAL, INLINE - SQUARE

A. Basis-of-Design Product: Subject to compliance with requirements a comparable product by one of the following:
1. Basis of Design: Greenheck
2. Available manufacturers offering products that may be incorporated into the Work include the following:
a. Loren Cook
b. Dayton

B. Source Limitations: Obtain square inline centrifugal fans from single manufacturer.

C. Description: Square-housing in-line centrifugal fans.

D. Standards: Comply with UL 705.

E. Housing:
1. Housing Material: Galvanized steel.

2. Housing Coating: None.
3. Housing Construction: Side panels are to be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

F. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

G. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

H. Motor Enclosure: Open, drip proof.

I. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor: Epoxy-coated steel.
5. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.
7. Adjustable belt kit to allow for field balancing.
8. Provide with factory disconnect.

2.3 VENTILATORS, CENTRIFUGAL - ROOF-MOUNTED DOWNBLAST

A. Basis-of-Design Product: Subject to compliance with requirements a comparable product by one of the following:
1. Basis of Design: Greenheck
2. Available manufacturers offering products that may be incorporated into the Work include the following:
a. Loren Cook
b. Dayton

B. Source Limitations: Obtain roof-mounted downblast centrifugal ventilators from single manufacturer.

C. Standards: Comply with UL 705.

D. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

E. Fan Wheels: Aluminum hub and wheel with backward-inclined blades; spark-resistant construction classified in accordance with AMCA 99, Section 8, Type B.

F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Provide with a spring to allow damper to fail close upon power loss.
4. Spark-resistant, all-aluminum wheel construction.

G. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 24 inches,
3. Pitch Mounting: Manufacture curb for roof slope.
4. Metal Liner: Galvanized steel.

2.4 VENTILATORS, CENTRIFUGAL - ROOF-MOUNTED UPBLAST

A. Basis-of-Design Product: Subject to compliance with requirements a comparable product by one of the following:
1. Basis of Design: Greenheck
2. Available manufacturers offering products that may be incorporated into the Work include the following:
a. Loren Cook
b. Dayton

B. Source Limitations: Obtain roof-mounted upblast or sidewall-mounted centrifugal ventilators from single manufacturer.

C. Standards:
1. Comply with UL 705.
2. Power ventilators for use with kitchen exhaust are to comply with UL 762.

D. Configuration: Centrifugal roof upblast, kitchen grease hood ventilator.

E. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

F. Fan Wheels: Aluminum hub and wheel with backward-inclined blades; spark-resistant construction classified in accordance with AMCA 99, Section 8, Type B.

G. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Provide with a spring to allow damper to fail close upon power loss.
4. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.
5. The grease spout shall be made of aluminum tubing, welded to the fan housing. The weld shall be factory tested to ensure no leaks.
6. Grease Box.
    a. Extended Drain for Field Supplied Grease Interceptor.
    b. Extended Drain for Thru Roof Grease Collection.

H. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.
1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 24 inch.
3. Pitch Mounting: Manufacture curb for roof slope.
4. Metal Liner: Galvanized steel.
5. Vented Curb: For kitchen exhaust; 24 inch- high galvanized steel; unlined, with louvered vents in vertical sides.
    a. Grease Drain
6. NFPA 96 code requirements for commercial cooking operations.
7. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

2.5 FANS, PROPELLER - SIDEWALL MOUNTED

A. Basis-of-Design Product: Subject to compliance with requirements a comparable product by one of the following:
1. Basis of Design: Greenheck
2. Available manufacturers offering products that may be incorporated into the Work include the following:
    a. Loren Cook
    b. Dayton

B. Source Limitations: Obtain sidewall-mounted propeller fans from single manufacturer.

C. Standards: Comply with UL 705.

D. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

E. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

F. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

G. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

H. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2.7 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.

C. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:
1. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

F. Unit Support: Install centrifugal fans level on structural curbs. Coordinate with duct connections. Coordinate wall penetrations and flashing with wall construction.

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation devices.
   1. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC."

H. Install units with adequate clearances for service and maintenance.

I. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK 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. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE:

A. Perform startup service.

1. Complete installation and startup checks in accordance with 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 ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, 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.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will 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 tests and inspections.
   1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safeties.
   3. Fans and components will be considered defective if they do not pass tests and inspections.
   4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 23 34 00

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SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Modulating, single-duct air terminal units with reheat
2. Modulating, single-duct air terminal units without reheat
3. Casing liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

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, and 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.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

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

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS WITH REHEAT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
   2. Price Industries Limited.
   3. Titus; brand of Johnson Controls International plc, Global Products.

B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 22-gauge- thick galvanized steel.
   1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Fibrous Glass" Paragraph with “Foil-Faced Liner” and "Antimicrobial Erosion-Resistant Coating" Subparagraph.
   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.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: AHRI 880 rated.

E. Flow Sensors: Do not provide air terminal unit with manufacturer provided flow/pressure sensors. Units to ship with no velocity sensor, provide EBTRON ELF ‘bead in glass’ thermistor probes (or equivalent) in place of manufacturer provided sensor.

F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.08 inch. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

G. Direct Digital Controls:
   1. Units to ship ‘dumb’ and have Automated Logic Controls or Delta Controls control boxes provided in the field.
   2. 24V control boxes to be powered from a 120V transformer provided under section ‘23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC’, located in valve and storage closets. 120V power drop to be provided under division 26 specifications.

H. Control Sequence: See Drawings for control sequences.

2.3 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS WITHOUT REHEAT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
   2. Price Industries Limited.

3. Titus; brand of Johnson Controls International plc, Global Products.

B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 22-gauge- thick galvanized steel.
1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Fibrous Glass" Paragraph with “Foil-Faced Liner” and "Antimicrobial Erosion-Resistant Coating" Subparagraph.
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.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated.

E. Flow Sensors: Do not provide air terminal unit with manufacturer provided flow/pressure sensors. Units to ship with no velocity sensor, provide EBTRON ELF ‘bead-in-glass’ thermistor probes (or equivalent) in place of manufacturer provided sensor.

F. Direct Digital Controls:
1. Terminal Unit Controller, Section 230923: Units to ship ‘dumb’ and have Automated Logic Controls or Delta Controls control boxes provided in the field. Field supplied control boxes to be compatible with EBTRON ELF airflow sensor.
2. 24V control boxes to be powered from a 120V transformer provided under section ‘23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC’, located in valve and storage closets. 120V power drop to be provided under division 26 specifications.

G. Control Sequence: See Drawings for control sequences.

2.4 CASING LINER

A. Casing Liner, Fibrous Glass: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A or NFPA 90B, and with NAIMA AH124.
1. Minimum Thickness: 1/2 inch.
2. Antimicrobial Erosion-Resistant Coating: Apply to surface of liner that will form interior surface of duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Foil-faced Liner: Minimum 0.01 inch reinforced, nonporous aluminum foil applied to matted insulation airstream face.

2.5 SOURCE QUALITY CONTROL

A. AHRI 880: Test and rate assembled air terminal units in accordance with AHRI 880.

B. Water Coils: Factory pressure test to 300 psig in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.

B. Install air terminal units' level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply piping with shutoff valve, strainer, control valve, and union or flange; and to return piping with balancing valve and union or flange.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

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

3.6 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows, and coil type. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks in accordance with 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.

3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
   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.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

SECTION 23 37 13.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rectangular and square ceiling diffusers.
2. Duct mounted diffusers.
3. Linear slot diffusers.

B. Related Requirements:
1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 23 37 13.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
2. Carnes Company.
3. Nailor Industries Inc.
4. Price Industries Limited.
5. Titus; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: See Schedule.

D. Finish: Baked enamel, white.

E. Face Size: 24 by 24 inches.

F. Face Style: as scheduled

G. Mounting: as scheduled.

H. Pattern: as scheduled

I. Accessories: as scheduled

2.2 DUCT MOUNTED DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
2. Carnes Company.
3. Nailor Industries Inc.
4. Price Industries Limited.
5. Titus; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Anodized aluminum.

E. Face Size: as scheduled

F. Mounting: Duct mounted.

G. Pattern: as scheduled.

H. Accessories: as scheduled

2.3 LINEAR SLOT DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
2. Carnes Company.
3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
4. Price Industries Limited.
5. Titus; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material - Shell: Steel, insulated.

D. Material - Pattern Controller and Tees: Aluminum.

E. Finish - Face and Shell: Baked enamel, black.

F. Finish - Pattern Controller: Baked enamel, black.

G. Finish - Tees: Baked enamel, white.

H. Slot Width: as scheduled.

I. Number of Slots: as scheduled.

J. Length: as scheduled.

K. Accessories: as scheduled.

L. Plenum shall be insulated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13.13

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SECTION 23 37 13.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fixed face grilles.

B. Related Requirements:
1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Show location and tags of registers and grilles in sheet metal shop drawings.

PART 2 - PRODUCTS

2.1 GRILLES

A. Fixed Face Grilles:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
a. Carnes Company.
b. Hart & Cooley, LLC.
c. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
d. Nailor Industries Inc.
e. Price Industries Limited.
f. Titus; brand of Johnson Controls International plc, Global Products.
g. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. Material: Steel, Aluminum, or Stainless steel as scheduled.
3. Finish: as scheduled.
4. Face Blade Arrangement: Horizontal, spaced ¾” apart.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Mounting: Countersunk screw or lay in as required for ceiling type.
8. Damper Type: Adjustable opposed blade for supply grilles only.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13.23

SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Louvered-penthouse ventilators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product

B. Shop Drawings: For gravity ventilators.
   1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads, Basis: Determine loads based on a uniform pressure of 20 lbf/sqft, acting inward or outward.
   2. Snow Load: Unit to withstand a minimum of 20 lbf/sqft snow load.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
   1. Temperature Change (Range):
      a. Ambient: 90 deg F.
      b. Material Surfaces: 180 deg F.

E. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

F. Capacities and Characteristics:
   1. See schedules.

2.2 LOUVERED-PENTHOUSE VENTILATORS

A. Description: Multitier rectangular louvered penthouse for intake and relief air.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck
   2. Loren Cook
   3. Twin City

C. Construction:
   1. Material: All-welded assembly with 4-inch deep louvers, mitered corners, and aluminum sheet roof.
   2. Frame and Blade Material, Extruded Aluminum: Thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades with condensate deflectors.
   3. Insulation: None.
   4. Wind-Driven Rain Performance: Not less than 80 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a free-area intake velocity of 500 fpm.
   5. Exterior Corners: Prefabricated corner units with mitered and welded blades.
   6. Bird Screening: Aluminum, ½-inch-square mesh

D. Dampers:
   1. Location: Curb damper tray.
   2. Control: Motorized.
   3. Tray: Provide damper tray or shelf with opening 3 inches less than interior curb dimensions indicated.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.
   1. Configuration: Built-in cant and mounting flange.
   2. Overall Height: 24 inches.

2.3 SOURCE QUALITY CONTROL

A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

2.4 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use hex-head screws for exposed fasteners unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware, that comply with the wind fastening requirements. Use concealed anchorages where possible. Refer to Section 077200 "Roof Accessories."

C. Install gravity ventilators with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

I. Refer to Section 077200 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.2 DUCT CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 37 23

SECTION 23 57 00 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gasketed-plate heat exchangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Design Calculations: Calculate requirements for selecting restraints and for designing bases.
   2. Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room plan or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Product Certificates: For each type of shell-and-tube heat exchanger. Documentation that shell-and-tube heat exchangers comply with "TEMA Standards."

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.
   1. Warranty Periods: From date of Substantial Completion.
      a. Plate Heat Exchangers:

1) Gasketed Brazed-Plate Type: One year.

PART 2 - PRODUCTS

2.1 GASKETED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Armstrong
2. Bell and Gossett
3. Alfa Laval
4. Wessels

B. Configuration: Freestanding assembly, consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Floor-mounted heat exchangers must have integral legs with mounting feet.

C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

D. Frame:
1. Capacity to accommodate 20 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

F. End-Plate Material: Painted carbon steel.

G. Tie Rods and Nuts: Steel or stainless steel.

H. Plate Material: 0.015 inch thick before stamping; Type 304 stainless steel.

I. Gasket Materials: Glued.
1. Glue: Chlorine free.

J. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
2. NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

K. Enclose plates in solid stainless steel removable shroud.

L. Capacities and Characteristics:

1. Refer to schedule

M. Pressure-Relief Valves: Brass, ASME rated and stamped.
1. Pressure-relief valve setting: 150 psig.

2.2 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME International label.

B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF HEAT EXCHANGER, GENERAL

A. Equipment Mounting:
1. Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Install floor-mounted and wall-hung steam heat exchangers at sufficient height, using sufficient length supports, to achieve required steam and condensate pipe pitch. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

3.2 INSTALLATION OF GASKETED-PLATE HEAT EXCHANGER

A. Install floor-mounted gasketed-plate heat exchangers on cast-in-place concrete equipment base, and fasten legs to base.

B. Install metal shroud over installed gasketed-plate heat exchanger in accordance with manufacturer's written instructions.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

C. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

D. Install shutoff valves at heat-exchanger inlet and outlet connections.

E. Pipe pressure-relief valves, full size of valve connection, to floor drain.

F. Install vacuum breaker at heat-exchanger steam inlet connection.

G. Install hose end valve to drain shell.

H. Install thermometer on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 230519 “Meters and Gauges for HVAC Piping”.

I. Install pressure gauges on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for pressure gauges specified in Section 230519 “Meters and Gauges for HVAC Piping”.

3.4 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.

C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

3.5 FIELD QUALITY CONTROL

A. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative:

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

D. Heat exchanger will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DEMONSTRATION

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

END OF SECTION 23 57 00

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SECTION 23 73 13.19 – CUSTOM AIR HANDLING AND DEDICATED OUTSIDE AIR UNITS, HEAT RECOVERY, MAKE UP 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. 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

1.2 SUMMARY

A. Section Includes:
   1. Custom Air Handling, Dedicated Outside Air, Heat Recovery and Make Up Air Units.

1.3 PERFORMANCE REQUIREMENTS

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified or as denoted on the drawings and schedule.

B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 125 percent of the operating static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span within the completed casings.

C. Environmental Loading Performance: Custom air-handling units shall withstand the effects of environmental loading (wind, snow, etc.) determined in accordance with the latest version of ASCE 7. Calculations to be performed by air-handling unit and curb manufacturer. Units located indoors are exempt from loading not encountered in an indoor environment.

D. Fans shall be rated in accordance with AMCA Standard 210 for performance and AMCA Standard 301 for sound and shall bear the AMCA seal.

E. Motor shall meet requirements of NEMA, IEEE, ANSI, and NEC standard.

F. Coils shall be rated in accordance with ARI Standard 410.

G. Equipment within unit shall be UL listed where applicable.

H. Complete air handling unit shall bear an ETL Label under UL Standard 1995.

I. Unit construction shall meet ASHRAE 62-1 requirements. Provide copy of certificate of compliance.

J. The installation of electrical components shall meet the requirements of the National Electrical Code (NFPA 70).

1.4 ACTION SUBMITTALS

A. Product Data: For each custom air-handling unit indicated.
   1. Shop drawings and datasheets that indicate unit components, installed dimensions, shipping and handling dimensions, weights, unit model number, capacities and clearances required for service/operation.
   2. Summary of all utility requirements (power/flow required, connection size, connection type, etc.) including but not limited too:
      a. Electrical connections.
      b. Hydronic connections.
      c. Drain connections.
      d. Air (ductwork) connections.
   3. Cabinet materials, finishes, and accessories.
   4. Manufacturer's performance of each component and the custom air-handling unit in its entirety including:
      a. Performance data for fans, coils, and energy exhangers.
      b. Input data used for the selection.
      c. Net capacity for all components stating the conditions used.
      d. Rated load.
      e. Fan curves.
      f. Internal static pressure loss calculations, including fan system effects.
      g. Finish and color chart.
      h. Filters with performance characteristics for the worst case stated operating condition.
      i. Specific Manufacturer system performance characteristics as tested by AHRI system performance at the following Outside Air Dry Bulb Temperatures: 0 deg F; 5 deg F; 17 deg F; 47 deg F; 95 deg F
   5. Test procedures for the tests indicated to be performed at the manufacturer's facility.

1.5 INFORMATIONAL SUBMITTALS

A. Provide an electronic copy of the service manuals for the equipment specified.

1.6 OPERATION AND MAINTENANCE CLOSEOUT SUBMITTAL

A. Provide manuals with detailed description of installation, operation, and maintenance, including the following:
   1. All approved “Certified for Construction” drawings.
   2. Written recommendations for field storage, both indoors and outdoors.
   3. Installation requirements including assembly instructions, lifting requirements and adjustments.
   4. Manufacturer’s literature describing each piece of equipment including operation and maintenance instructions.

5. Factory test reports.
6. Manuals shall be provided within three weeks after shipment of the air handling units.

B. Provide a printed copy of installation, operation, and maintenance (service) manual with equipment shipment.

1.7 WARRANTY:

A. All equipment, materials, and workmanship shall be warranted for twelve (12) months from startup or eighteen (18) months from shipment, whichever period expires first.

B. Warranty to cover parts only; labor to remove or reinstall parts will be the responsibility of others.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Buffalo Air Handling.

B. Available manufacturers offering products that may be incorporated into the Work include the following:
1. Air Enterprises
2. Environmental Air Systems.

C. The equipment manufacturer shall have been manufacturing custom built air handling units for a minimum of twenty-five (25) years.

2.2 GENERAL

A. Units shall not be smaller than shown on the drawings. Units shall be completely factory assembled and tested. The equipment's cooling, heating, humidifying, ventilating, exhausting capacity and performance shall meet or exceed that shown on the schedule. Tags and decals to aid in service or indicate caution areas shall be provided.

2.3 CABINET CONSTRUCTION

A. Units shall be shipped in one piece when possible. Units shipped in multiple sections shall be engineered for field assembly and testing. Provide full length perimeter angles located inside units at shipping splits to allow for field bolting of modular sections. Unit manufacturer to provide necessary hardware, sealing gasket, and caulk required to field join and seal the shipping split sections.

B. Units requiring knockdown (KD) construction must be completely assembled in the factory prior to disassembly and palletization. Manufacturers shall include services of a field technician to supervise the contractors field reassembly of the air handling unit.

C. The manufacturer's standard cabinet construction shall result in a unit leakage rate that shall not exceed 0.5% of unit capacity at 1.5 times the operating static pressure.

D. All panels shall be 3-inch double wall and fabricated of a 0.063-inch stucco aluminum outer shell with a 0.050-inch smooth aluminum inner liner. The unit casing shall be of no metal construction using aluminum extrusions with a polyurethane resin thermal bridge.

E. All unit casing panels, and roof shall be insulated with 3-inch-thick foam insulation fill injected between the outer wall and inner liner for maximum strength and foam to metal adhesion. The insulation shall have a minimum U-value of 0.049 btu/hr-sqft- deg F and shall have a flame-spread index of 25 or less and a smoke-developed index of 50 or less.

F. All panel seams are to be externally caulked with sealant.

2.4 ROOFING

A. Outdoor units shall incorporate a sloped roof with a minimum 1/4 inch per foot (2%) slope to assure positive run-off.

B. Roof to be peaked on door side and drain away from the access door side.

C. Roof shall have turned up and capped flanges.

D. For air handling units over 20 feet in width roof shall be peaked in the center and sloped to both sides.

2.5 BASE CONSTRUCTION

A. The units shall be constructed on a minimum 8-inch high, structural aluminum, full perimeter channel base to minimize unit weight for installation. The floor shall be insulated with a minimum of 1.5-inch-thick foam insulation. Tubular or formed channel steel shall not be used as the perimeter base unless the base is comprised of stainless steel. The under-floor insulation shall be protected with a 0.0040-inch aluminum coversheet. Floors and walls shall be designed so that deflection is limited to no more than L/240 of the span dimension at unit operating pressures.

B. The base frame shall have removable lifting lugs. The lifting lugs shall be fabricated from 1/2 inch steel with an appropriate rigging hole. Lifting lugs shall be located and sized to allow rigging and handling of the unit.

C. Floor Construction:
1. The unit floor is to be constructed of a minimum of 3/16-inch aluminum tread plate.
2. Floor Seams: Continuously welded seams.
3. 2 inch turned-up lips around the perimeter of each shipping section and at each opening in the floor.

4. Floor drains: Provide in each section to accommodate wash-down and piped to the exterior of the unit. Drains shall be minimum 1-inch MPT and provided with a removable drain cap.
5. Floor shall be welded to the base substructure and designed to prevent oil canning.

2.6 DRAIN PANS

A. Drain pans serving cooling and heat recovery coils shall be continuously welded, positively draining, triple-sloped and constructed from 12 gauge 304 stainless steel and shall extend a minimum of 3 inches upstream and 18 inches downstream. The drain pan shall be recessed with a minimum depth of 2 inches at the drain. Drain pan shall have a minimum connection size of 2 inches or sufficient size to remove condensate (whichever is greater) extended to the exterior for connection by the contractor. Plastic drain pans and plastic drain lines are not acceptable. Caulking the drain pan seams is unacceptable. The drain pan shall be insulated with a minimum of 1.5 inches thick foam insulation and covered by a minimum 0.0040 inch aluminum coversheet.

B. Drain pans serving non-coil devices shall be continuously-welded, positively draining, triple-sloped and constructed from 1/8 inch aluminum and shall extend a minimum of 3 inches upstream and 24 inches downstream. The drain pan shall be recessed with a minimum depth of 4 inches at the drain. Drain pan shall have a minimum connection size of 2 inches sufficient size to remove condensate (whichever is greater) extended to the exterior for connection by the contractor. Plastic drain pans and plastic drain lines are not acceptable. Caulking the drain pan seams is unacceptable. The drain pan shall be insulated with a minimum of 1.5 inches thick foam insulation and covered by a minimum 0.0040-inch aluminum coversheet.

2.7 ACCESS DOORS

A. Access doors shall be same construction as unit casing; double wall, completely insulated between the interior and exterior sheet metal of the door and attached to an extruded aluminum frame.

B. All doors shall have an offset frame incorporating a double gasket seal.

C. Thermal Break: Provide doors and door frames downstream of the cooling coil section with an integral thermal break.

D. Hinges: Provide each door with a single-continuous heavy-duty stainless piano hinge.

E. High compression latches, operable from both sides of the door, shall be used. Latches shall be Ventlok 310 Standard Finish.

F. Minimum Door Size: The nominal door size shall be a minimum of 20 inches wide as noted on drawings and as tall as unit allows and shall open against the section's operating pressure.

G. Door viewports shall be a minimum of 12 inches x 12 inches constructed of a thermal double-paned Mylar shatter proof design with inert gas. Viewports shall be rated to prevent transmission of UVC rays.

H. Test Port: Provide each door with a 3/4-inch , schedule 80 CPVC test port complete with end cap.

I. Doorstops: Door stops shall be provided to prevent the out swinging doors being opened wide enough to damage to the door, casing, or components.

J. Drip Cap: All inswing doors on outdoor units shall be provided with a drip cap above the door (minimum width equal to the door width).

2.8 REMOVABLE PANELS

A. Removable panels shall be provided as indicated on the drawings for component removal and replacement only. Removable panels shall be of the same construction as panels described above. Removable panels shall be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels.

2.9 CORROSION PROTECTION SYSTEM

A. Carbon steel components shall be shot-blasted and painted with a Red-Oxide epoxy primer to protect against corrosion.

B. Aluminum or 304 SS exterior casing surfaces do not require painting.

2.10 FANS (GENERAL)

A. Manufacturers:
1. Twin City Fan and Blower.
2. Greenheck.
3. Loren Cook

B. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating, as defined by the fan performance curve at the selected operating speed.

C. All fans shall meet the air flow performance specified and shall not exceed the brake horsepower or sound power levels specified on the mechanical equipment schedule (if applicable). Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300.

D. Fan assemblies shall be designed for heavy-duty applications, class 2 minimum return fan, Class 3 supply fan construction or as scheduled.

E. Fan framing assemblies shall be fabricated from structural steel. Formed members are not acceptable.

F. Inlet cones shall be precision spun or die formed. Inlet cones shall be aerodynamically matched to the wheel side plate to provide streamlined airflow in the wheel and ensure full loading of the blades.

G. All fans shall be coated and designed for rugged industrial duty and suitable for continuous operation at the maximum-rate speed and motor horsepower.

H. Fan shafts shall be solid AISI 1040 or 1045 steel. Shafts shall be turned, ground and polished to a minimum 16 micro-inch finish. Shafts shall be sized to run at a minimum of 20% greater than the maximum AMCA class speed.

I. Piezometer Ring: Fans shall be provided with a piezometer ring air flow measuring station around the fan inlet to provide airflow measurement back to the building management system. The ring shall contain a minimum of four orifice ports located in the throat of the fan inlet that are connected with tubing in a continuous ring. Piezometer ring shall be integral to the fan construction. Copper pneumatic tubing shall be routed from the piezometer ring to the control panel on the exterior of the unit. Airflow transducer shall be provided at the exterior of the unit. Airflow sensor shall be autozeroing and high precision.

2.11 PLENUM FANS

A. Basis of Design:
   1. Twin City Fan Model EPF/EPQ/EPFN/EPQN
   2. Greenheck Model APH

B. Fan Wheel:
   1. Wheels 24.5-inch Diameter and Smaller: Provide wheel with airfoil-shaped extruded aluminum blades, and non-tapered style blade retaining ring on inlet side. Fabricate hollow blade wheels with continuous welds around edges.
   2. Wheels 27 InchDiameter and Larger: Provide wheel with airfoil-shaped extruded aluminum blades, and non-tapered style blade retaining ring on inlet side. Fabricate hollow blade wheels with continuous welds around edges.

C. Housing: None.

D. Coating: All carbon steel components shall be cleaned and painted with the fan manufacturer's standard paint.

E. Fan Base: The fan and motor are to be mounted on all-welded structural steel, epoxy-mastic coated, internal isolation base with springs selected to provide a minimum of 97% isolation efficiency. Each spring shall be seismically rated for a Category A zone per ASCE, have a minimum of 2 inches nominal deflection, housed type, welded to a base plate with a 1/4 inch thick ribbed neoprene sound deadening pad and leveling bolt. Base plates shall be mounted on two threaded studs welded to unit floor for ease of spring replacement. The outlet of the fan is to be separated from the unit casing by means of a factory installed flexible connection.

F. Flexible Connection: Provide flexible connection between fan and fan bulkhead. Fan assembly shall be provided with thrust restraints, or thrust bumpers, to prevent damage to the flex connection. Flex connection material shall have a flame-spread index of 25 or less and a smoke-developed index of 50 or less A.

G. Inlet Screen: Welded wire safety screens.

H. Outlet Guard: Welded wire safety screens open at the bottom.

I. Piezometer Ring: Fans shall be provided with a piezometer ring air flow measuring station around the fan inlet to provide airflow measurement back to the building management system. The ring shall contain a minimum of four orifice ports located in the throat of the fan inlet that are connected with tubing in a continuous ring. Piezometer ring shall be integral to the fan construction. Copper pneumatic tubing shall be routed from the piezometer ring to the control panel on the exterior of the unit. Airflow transducer shall be provided at the exterior of the unit. Airflow sensor shall be autozeroing and high precision.

2.12 FAN SECTION ACCESSORIES

A. The fan section shall include a structural I-beam monorail capable of lifting the motor through the fan section access door in the side of the unit.

2.13 MOTORS

A. Manufacturers:
1. WEG
2. Baldor-Reliance
3. GE
4. Toshiba

B. General Motor Requirements:
1. Comply with NEMA MG 1 unless otherwise indicated.
2. Comply with IEEE 841 for severe-duty motors.
3. Motors should be suitable for use with variable frequency drives (VFDs).

C. Motor Characteristics

1. Duty: Continuous duty at an ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
2. 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 factors.
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. Efficiency: NEMA Premium Efficient.
5. Enclosure Type: TEFC. TEAO enclosures are not an acceptable alternative.
6. Turndown Ratio: Motor shall be able to reduce speed to 1/20 of the nominal RPM without adversely effecting motor performance.
7. Frame Material: Cast iron.
8. Bearings: Shielded, antifriction ball bearings suitable for radial and thrust loading.
9. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
10. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
11. Inverter-Duty EC Motors: Class F temperature rise; Class H insulation.
12. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
13. Shaft-Grounding Ring: Provide on each motor shaft.
14. Service Factor: 1.15.

2.14 COOLING COILS (WATER OR GLYCOL)

A. Manufacturer:
   1. Basis of Design: Aerofin
   2. Available manufacturers offering products that may be incorporated into the Work include the following:
      a. Heatcraft
      b. RAE.

B. All coils shall meet or exceed all capacities specified on the mechanical schedule for the project. All water coil performances shall be certified by the manufacturer to be in accordance with ARI Standard 410. Coils shall be mounted in the unit for horizontal airflow. Coil air face velocities shall not exceed 450 FPM or as scheduled per unit.

C. All coils shall be tested to 250 psig compressed air under water. Coils shall be designed to operate at 250 psig internal pressure and up to 300°F.

D. Coils shall not act as structural component of units.

E. Fabricate coil section to allow removal, replacement, service, and maintenance of the coil(s).

F. Split coils shall be individually supported by a 304 stainless steel rack system for independent coil removal, so that, in the case of split coils, one coil can be removed without disturbing the other. Coils stacked one directly on top of the other will not be accepted. Units with split coils in this project as the basis of design are AHU-1, AHU-2, AHU-4 and DOAS-1.

G. For split coils, a triple sloped, positive draining intermediate condensate drain pan with recessed drain connection shall be provided. Intermediate condensate drain pans shall extend underneath each coil a minimum of 3 inches upstream and sufficient length downstream of each coil (as described below) to contain potential carryover. Each intermediate drain pan shall be individually piped (non-cascading) down to the main drain pan. Intermediate drain pans and drainpipes shall be type 304 stainless steel. Downspouts to be a minimum 1-1/2-inch stainless steel. Plastic downspouts are not acceptable.
   1. Downstream intermediate condensate pan length:
      a. Coil finned height ≤ 30 inches:6 inches.
      b. 30 inches < Coil finned height ≤ 38 inches:9 inches.
      c. 38 inches < Coil finned height ≤ 45 inches:12 inches.
      d. Coil finned height > 45 inches:15 inches.

H. Provide removable access panels in the unit casing for ease of coil removal.

I. Chilled water coils shall be constructed with the following characteristics:
   1. Fluid: See schedule.
   2. Tubes: 0.025 inch thick, 5/8-inch diameter, seamless copper tubes.
   3. Fins: 0.0075-inch aluminum fins.
   4. Headers: Non-ferrous headers with steel MPT connections.
   5. Drain and Vent: Minimum 3/8-inch diameter MPT drain and vent connections.
   6. Coil casings shall be constructed of a minimum of 16-gauge 304 stainless steel.
   7. Coil connections are to be extended through the unit casing wall by the unit manufacturer. Drain and vent connections shall be terminated internally.
   8. Coil casing reinforcement: Required for fin lengths exceeding 42 inches.
   9. Maximum Finned Height per Coil: 48 inches.
   10. Maximum Fin Density: Shall not exceed 12 fins per inch.

2.15 HEATING COILS (WATER OR GLYCOL)

A. Manufacturer:
   1. Basis of Design: Aerofin
   2. Available manufacturers offering products that may be incorporated into the Work include the following:
      a. Heatcraft
      b. RAE.

B. All coils shall meet or exceed all capacities specified on the mechanical schedule for the project. All water coil performances shall be certified by the manufacturer to be in accordance with ARI Standard 410. Coils shall be mounted in the unit for horizontal airflow. Coil air face velocities shall not exceed 600 FPM or as scheduled.

C. All coils shall be tested to 250 psig compressed air under water. Coils shall be designed to operate at 250 psig internal pressure and up to 300°F.

D. Coils shall be circuited to provide the required performance. The use of internal restrictive devices, or turbulators, to obtain turbulent flow will not be acceptable.

E. Coils shall not act as structural component of units.

F. Fabricate coil section to allow removal, replacement, service, and maintenance of the coil(s). Split coils shall be individually supported by a 304 stainless steel rack system for independent coil removal, so that, in the case of split coils, one coil can be removed without disturbing the other. Coils stacked one directly on top of the other will not be accepted. Units with split coils in this project as the basis of design are AHU-1, AHU-2, AHU-4 and DOAS-1.

G. Coils shall be individually supported by a minimum 1/8" aluminum rack system for independent coil removal.

H. Provide removable access panels in the unit casing on for ease of coil removal.

I. Hot water coils shall be constructed with the following characteristics:
   1. Fluid: See schedule.
   2. Tubes: 0.025 inch thick, 5/8-inch diameter, seamless copper tubes.
   3. Fins: 0.0075-inch aluminum fins.
   4. Headers: Steel headers with steel MPT connections.
   5. Drain and Vent: Minimum 3/8-inch diameter MPT drain and vent connections.
   6. Coil casings shall be constructed of a minimum of 16ga galvanized steel.
   7. Coil connections are to be extended through the unit casing wall by the unit manufacturer. Drain and vent connections shall be terminated internally.
   8. Coil casing reinforcement: Required for fin lengths exceeding 42 inches.
   9. Maximum Finned Height per Coil: 56 inches.
   10. Maximum Fin Density: Shall not exceed 12 fins per inch.
   11. Tube fluid velocities shall be between 2 fps and 8 fps.

2.16 FILTERS

A. Manufacturers:
   1. American Air Filter
   2. Camfil USA.
   3. Flanders.

B. General:

1. Provide all filters of type, quantity, size and capacity as required for air handling system indicated on drawings and as stated in these specifications.
2. Filters to be selected for a maximum face velocity of 500 FPM.
3. Filter initial pressure drop shall not exceed the rating indicated for each filter media type listed below.
4. Fan(s) will be rated based on the final resistance indicated for each filter type listed below.
5. Each cell should be 24 inches x 24 inches, or 12 inches x 24 inches.
6. Media shall be approved and listed as Underwriters Laboratories (UL) Standard 900.
7. Media shall be tested in accordance with the latest version of ASHRAE Standard 52.2.

C. Filter Media:
   1. Medium Efficiency Pleated Pre-filters:
      a. Depth: 4 inch.
      b. MERV Rating: 8
      c. Initial resistance at 500 FPMhall not exceed 0.28 in H2O.
      d. Final resistance at 500 FPM 0.90 in H2O.
      e. Based on AAF Perfect Pleat HC M8 | Camfil 30/30.
   2. High Efficiency Rigid Final Filters:
      a. Depth: 12 inches.
      b. MERV Rating: 13.
      c. Initial resistance at 500 FPM shall not exceed:
         1) MERV 13: 0.60 in H2O.
      d. Final resistance at 500 FPM: 1.30 in H2O.
      e. Based on AAF Varicel RF | Camfil Riga-Flo.

D. Frame Construction:
   1. “Type 8” filter holding frames: Heavy-duty construction designed for institutional applications:
      a. Material: Minimum 16-gauge galvanized steel.
      b. Gasket: Closed-cell foam.
      c. Filter fastener attachments: Attachment points shall permit the installation of filter fasteners without the requirements of tools, nuts, or bolts.
      d. Reinforcement: Filter banks larger than 60 inches wide by three 72 inches tall shall be reinforced to prevent appreciable deflection under “dirty” filter conditions at the design airflow.
      e. Filter removal: Holding frames permit either upstream or downstream filter removal.

E. Differential Pressure Dial Gauge: A differential pressure gauge for measuring the pressure drop across each filter bank shall be installed. Gauges installed in outdoor environments shall be suitable for use in outdoor environments or provided with an enclosure with a clear door to enable viewing of gauges without opening the enclosure. The gauge shall be dial type with white dial face, black or blue figures and graduations and pointer zero adjustment. Gauge shall be surface mounted. Recessing gauges into unit casing shall not be acceptable.

2.17 DAMPERS

A. Manufacturers:
1. Ruskin.
2. Tamco.

B. General Requirements:
1. Sizing:
a. Wall Duct Connections: Max 1800 FPM.
b. Floor Openings: Max 1200 FPM.
c. Ducted Economizer Exhaust: Max 1800 FPM.
d. Ducted Economizer Mixed / Return Air: Max 1500 FPM.
e. Ducted Economizer Outdoor Air: Max 1200 FPM.
2. Mounting: All dampers should be provided with a front-, rear-, or double-flange for mounting unless it can be demonstrated that providing flanges will interfere with damper installation.
3. Location:
a. Exposed to unit interior or indoor environment: Aluminum Control.

C. Aluminum Control Dampers:
1. Blades: Aluminum, airfoil blade.
2. Frame: Aluminum.
3. Blade Stops: Not to exceed 1.25 inches in height.
4. Blade Seals: Extruded EPDM or neoprene mechanically attached to blade.
5. Jamb Seals: 304SS compression or extruded silicone.
6. Axles: Plated-Steel, mechanically fastened or integral to blade
7. Bearings: Molded synthetic sleeve or dual-bearing system.
8. Linkage: Aluminum and/or zinc-plated steel hardware concealed in damper frame.
9. Leakage: AMCA Standard 511 leakage class 1A 1 in. wg.
10. Based on Ruskin CD50 | Tamco 1000/1500.

D. Backdraft Dampers:
1. Blades: Aluminum.
2. Frame: Aluminum.
3. Blade Seals: Vinyl or silicone mechanically attached to blade.
4. Jamb Seals: Extruded silicone.
5. Axles: Synthetic or aluminum, mechanically fastened or integral to blade
6. Bearings: Synthetic, maintenance free.
7. Linkage: Aluminum and/or zinc-plated steel hardware concealed in damper frame.

8. Leakage: AMCA Standard 511 leakage class 2 at 1 in. wg.
9. Based on Ruskin BD6 | Tamco 7000

2.18 ENERGY RECOVERY WHEELS HEAT RECOVERY WHEEL: Thermotech Enterprises TF- Series Wheel

A. Manufacturers:
1. Thermotech.
2. Semco

B. The structural frame and casing shall be designed and manufactured so as to allow a maximum rotor deflection of 1/32 inch, as measured at the outer radius, during maximum rated airflow conditions.

C. All sheet metal shall be reinforced as required to provide a solid mounting surface of the peripheral and radial seals in order to maintain a minimum of ¾ inch fixed distance between the rotor surface and any sheet metal or steel parts. There shall be no special requirement to provide any casing side access for future rotor removal and/or service. All such service work shall be possible to perform from inside the duct at the face of the rotor casing.

D. A purge section shall be provided to eliminate transfer of exhaust air into the supply air and shall be field adjustable.

E. Bearings shall be framing mounted pillow block type with external tapered roller bearings. Double set screw locking collars shall be provided and sized for a minimum L-10 life of 1,000,000 hours of operation and shall be changeable without a complete disassembly of the rotor. Shaft journals shall be machined to proper tolerance as specified by the bearing manufacturer. Shaft shall be machined as to provide a shoulder against the bearings for a positive locked position to eliminate any lateral movement of the rotor due to axial bearing loads. Grease fittings shall be easily accessible.

F. The spokes shall be made of extruded aluminum with an “I” beam shape to limit deflection of the rotor to 1/32 inch for the maximum rated airflow. Spoke surfaces to be serrated for increased friction and air turbulence across the seals.

G. The rim joint shall connect the spoke ends, and the rim ends together in such a way that the heat transfer media can be installed under field conditions without any media deformation or misfits causing future problems. The rim joints provide a gradual compression of each section by independently applying increased tension of the rim bolts without the use of any special tools or devices.

H. The rims shall be made of two extruded aluminum sections -- one inner rim and one outer rim with grooves for the twin “V” belts, and guide flanges for securing the media. The two sections shall be welded together to form a tubular structure for improved strength in order to maintain an accurate radius and rotor roundness during the manufacturing process.

I. The rotor media shall be provided in segments to allow for field erection or replacement of one section of media at a time without side access. No external pullers or other special tooling shall be required for field assembly or replacement. The media shall be machined to fit in between primary and secondary spoke and a guiding flange of the outside rim. Each media segment shall be compressed independently of all other segments during manufacturing without causing any angular deformation and resulting misfits between the spokes and media parts. The results shall be a wheel with a flatness of +/- 1/32 inch. No adhesive or silicone shall be necessary to secure the media in place.

J. The enthalpy heat transfer media shall be the industry standard of 200 mm. in depth. Non-standard depths shall be unacceptable. The heat transfer media shall be made out of corrugated aluminum foil with a high surface area per volume and laminar flow to assure that no fouling occurs on the internal heat transfer surface. Dry particles up to 900 microns shall pass freely through the media. This material shall be supplied with a “Balanced Sieve” 3A Molecular Sieve hygroscopic solid desiccant coating for selective adsorption of water vapor and equal sensible and latent heat transfer. The media shall have a flame spread of 0 and a smoke developed of 5 or less when rated in accordance with ASTM E84-09. All edges shall have an anti-corrosion epoxy coating.

K. Rotor media shall be tested in accordance with ASHRAE Standard 84-91 and ARI Standard 1060-01 by a qualified independent testing laboratory. Testing shall confirm published performance and document that the desiccant material does not transfer pollutants typically encountered in the indoor air environment. The reports shall be provided upon request.

L. The seals shall be of a maintenance free “non-contact” type with a 4-pass labyrinth “turbine” for optimum performance and designed to eliminate wear and excessive drag. The seals shall be adjustable and set to within 0.05 inch of the rotor surface and must be bolted to the frame with stainless steel hardware to eliminate seal movement. The seal system shall withstand a pressure difference up to 12 in. W.C.

M. The drive system shall be gravity tensioned and shall use two standard “B” section V-belts that must ride in a groove in the rotor rim to eliminate any side-to-side movements and slippage or the drive system shall be a direct drive gear motor mounted directly on the center shaft and shall incorporate a torque arm. The speed reducer should be grease lubricated, maintenance free with a flexible Love-Joy input coupling for easy motor separation and for absorption of any shock or vibration.

N. The speed control system shall be a variable frequency inverter operating a standard inverter rated AC motor, capable of operating the rotor from 1/4 rpm to 20 rpm or to whatever is required for the type of media used. It shall integrate with the temperature control system to provide the required air supply temperature.

O. The temperature controller shall monitor entering and leaving temperature for the exhaust and supply air. Adjustable set points shall be for the heating mode discharge temperature, summer/winter change over and for wheel frost control. For multiple rotors in a common air stream each rotor shall provide temperature outputs to the controller to get an accurate average discharge temperature.

P. The rotation detector shall be accomplished through th`e temperature controller. A proximity sensor and target shall provide the contact for the controller used to provide RPM readout and wheel stoppage alarm contacts.

Q. Energy recovery wheel control panel with VSD shall be factory mounted and wired by Custom air handling unit manufacturers to energy recovery drive motor, temperature/humidity sensors and rotation sensors.

R. The entire rotor and wheel assembly shall require only limited maintenance of biannual greasing of the main bearings and inspection of the drive system.

S. A standard 10-year material and labor warranty shall be provided covering all materials supplied and installed.

T. Face and bypass dampers shall be provided to allow for bypassing the wheel.

2.19 CONTROLS

A. Controls wiring for the energy recovery wheel to the wheel cassette shall be factory wired, including but not limited to the four (4) integral combination temperature and humidity sensors.

B. Pneumatic tubing for the fan’s piezometer ring shall be piped to the exterior mounted control panel.

C. Four (4) 1” conduits shall be provided with each unit, down the full length of the unit. Control wiring conduit shall punch through the unit casing. Penetrations shall be sealed to provide a tight ‘portal’ to allow run wiring in and out of the unit without need for penetrating the casing. Portals shall be located to allow access to them.

D. The factory shall provide thermally isolated support structures where temperature sensors are shown integral to the units in controls drawings and are not provided with the energy recovery sections. This thermally isolated support structure will allow the a series of thermistors to create a temperature averaging of the airflow through that section of the unit. These support structures shall be in the return air stream, and in the supply air stream both upstream and downstream of the coils. Factory shall coordinate with the control’s drawings, engineer of record and contractor to locate these support structures.

2.20 ELECTRICAL

A. General:

1. All electrical work shall be installed in full compliance with the National Electric Code and all local codes and requirements.
2. Where applicable, components shall bear UL listed, UL recognized, or ETL listing marks.
3. All wiring and components inside air handling plenums shall be weatherproof and rated for such use.

B. Routing:
   1. Conduit
      a. All wiring shall be run in EMT conduit utilizing compression type fittings.
      b. All conduit in wet sections and on the exterior of outdoor units (including but not limited to outdoor air intakes, humidifier, and cooling coil sections) shall be rigid aluminum.
      c. All conduit penetrations in the unit housing and penetrations across air seal and insulated walls shall be internally sealed airtight with caulk to prevent the migration of water vapor in the conduit.
   2. Conductors: All power conductors to be 600V rated, copper MTW, THHN, or THWN.
   3. Shipping-splits:
      a. A junction box shall be provided at each shipping-split to aid in field connection of wiring.
      b. All conductors servicing circuits 300V or less shall be spliced with wire nuts at each shipping split.
      c. All conductors servicing circuits greater then 300V shall be pulled back to the shipping split nearest to the component served. Alternatively, circuits may be spliced with the aid of panel mounted terminal blocks rated for the voltage and current of the application. Other means of splicing are not permitted.
   4. Boxes, Enclosures, and Cabinets:
      a. All boxes, enclosures and cabinets exposed to the outdoor environment shall be NEMA 3R rated.
      b. All boxes, enclosures, and cabinets exposed to the indoor environment or within service corridors shall be NEMA 1 rated.

C. Motors:
   1. Each motor shall be wired to a Junction box located on the exterior of the unit.
   2. Motor wiring to each motor shall be in separate conduits. Wiring multiple motors within the same conduit, wireway, or trough is not permitted.
   3. Control wiring shall not be located in the same conduit(s) as power wiring.

D. Lighting: Each access section of the unit shall be provided with one vapor-proof LED light fixture with bulb, light fixture for every access section. Lighting circuits shall be wired a common 120V feed location. Lighting shall be controlled with 20A rated, 2-way w/ pilot light switches. Bulbs for light fixtures shall be provided by the contractor.

E. For units 20 feet long or greater, a minimum of two light switches shall be provided. Light switches shall be located at the fan and filter section access doors.

F. Convenience Receptacles: Each fan section shall be provided with a duplex, 20-amp GFCI receptacle wired to a common 120V feed location. Receptacles for use in outdoor or wet environments shall bear the “WR” mark and be enclosed with a while-in-use cover.

G. Field Wiring Connections
   1. All 460V connections shall terminate at each component junction box, VFD, or disconnect.
   2. All 120V wiring shall be wired to a common point terminating in a junction box.

H. VFDs shall be provided in the field. Manufacturer to coordinate with contractors to ensure electrical components of the custom-built units are compatible with field supplied VFDs.

2.21 SERVICE CORRIDOR

A. Roof mounted units shall be provided with a manufacturer furnished service corridor providing a wind and rain free space for maintenance of the roof mounted units. The service corridor shall be built using the materials and methods describing the construction of the DOAS/AHUs/MAUs in this specification. Contractor shall install the corridor.

B. The service corridor shall be roughly 325”x104”x116”, LxWxH. Coordinate final service corridor dimensions with final dimensions of the roof mounted units.

C. If different manufacturers are used for roof mounted units, it is the contractor’s responsibility to coordinate the separate manufacturers requirements for the service corridor.

D. Service corridor shall be a provided with a lighting system provide maintenance staff a bright, well-lit room to work in

E. Service corridor shall be provided with an electronic 5kW unit heater and thermostat.

F. Service corridor shall be provided with a gravity damper on one end and a 1/8th horsepower wall mounted propeller fan on the other end. Both damper and fan to have bird screen and weather hoods.

G. Stairs shall be provided up from the roof to the corridor access dor.

PART 3 - EXECUTION

3.1 UNIT FACTORY TESTING

A. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment. A representative of the owner, the installing contractor, and the engineer may witness the testing if they choose. The manufacture must notify the parties involved a minimum of two weeks prior to testing.

B. Cabinet Leak Testing: The cabinet shall be tested at the unit's design operating static pressures for both the high- and low-pressure sides. Unit leakage rate shall not exceed 0.5% of unit airflow capacity at 1.5 times the operating static pressure (50 cfm minimum per air tunnel. Leak testing shall be performed by measuring the airflow used to pressurize the air handling unit positively or negatively at the cabinet design operating static pressure via a calibrated orifice method. All supply and return air openings shall be sealed along with the air seal at the supply fan bulkhead wall to isolate the high and low side of the unit. The unit shall then be pressurized with air until the appropriate operating static pressures are achieved.

C. Cabinet Deflection Testing: A unit deflection test shall be conducted at 1.15 times the peak fan shutoff static pressure on the supply fan performance curve (not to exceed 15 in. H2O). Deflection shall not exceed L/200.

D. Fan Vibration Testing: Fan wheel and shaft assemblies shall be dynamically analyzed after the fan, motor and drive assemblies have been installed in the unit. The fan is analyzed with an electronic balance analyzer with a tunable filter. Vibration measurements are taken on each bearing housing in the horizontal, vertical, and axial positions with the filter tuned to the fan RPM. The maximum acceptable filter-in vibration reading for at any of the tested positions shall not exceed 0.16 inches per second. The testing shall be performed at the factory and witnessed by the owner's representatives. A detailed report, including all data and test methods, shall be presented to the owner.

3.2 START-UP

A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:
   1. Inspect field assembly of components and installation of central-station air-handling units.
   2. Prepare a written report on findings and recommended corrective actions.
   3. Unit start-up

B. Final Checks before Startup: The installing contractor shall perform the following before startup:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that piping, ductwork, and electrical connections are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
   3. Verify 120V and 460V power are brought to air handling unit.
   4. Verify all shipping splits are sealed.

5. Verify proper motor rotation direction, free fan wheel rotation and smooth bearings operations. Check fan drive system for alignment and proper belt tension.
6. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
7. Set outside-air and return-air mixing dampers to minimum outside-air setting.
8. Comb coil fins for parallel orientation.
9. Install clean filters.
10. Verify that zone dampers, manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

C. Start-Up Procedures for Custom Air Handling Units: The manufacturer’s start-up service technician shall perform the following:
1. Check all foundations: fan, isolator base and motor bolts for tightness.
2. Check set screws in the fan wheel hub for tightness to shaft.
3. Remove fan bearing caps and check for proper amount of grease.
4. Check for proper locking ring position in the held bearing.
5. Check the set screws in the bearings to ensure the bearing is locked.
6. Check height of the isolation base to ensure that the base and isolators are level.
7. Check to insure all shipping hold down brackets have been removed.
8. Bump fan/motor to check for proper wheel rotation.
9. Bring fan up to speed, checking for noise, vibration, pulsations, etc.
10. Check vibration levels on the fan and motor bearings. Rebalance if necessary.
11. Measure and record motor electrical values for voltage, amperage and horsepower.
12. Check for any damage to the unit interior and exterior. Repair, if necessary.
13. Check all lights, doors, door handles, filter gauges for any damage. Repair if necessary.
14. Check all coil fins for damage. Repair if necessary.
15. Check all dampers for proper movement and operation of the blades.
16. Manually operate dampers from fully closed to fully open position.

D. Operation and Maintenance Manuals: Manual shall be provided complete with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance and lubrication recommendation and schedule.

3.3 DEMONSTRATION

A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."

C. Schedule all training with a minimum ten (10) days' advance notice.

D. Manufacturer’s representative shall provide Joining supervision during field construction of the units.

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SECTION 23 81 26 - SPLIT-SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Split-system heat-pump units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: 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.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system heat-pump units that fail in materials or workmanship within specified warranty period.
1. Warranty Period:
a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. For Split Systems
a. Mitsubishi.
b. Lennox International Inc.
c. Trane.
d. YORK; a Johnson Controls company.

2.2 SPLIT-SYSTEM HEAT-PUMPS

A. Indoor Units – Wall Mounted Evaporator-Fan Components:
1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner or double wall foamed.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal- expansion valve. Comply with AHRI 210/240.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motor: High efficiency electronically commutated motor (ECM).
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the current version of ASHRAE 62.1.
7. Mount unit mounted disconnect switches on exterior of unit.
8. Filters: Disposable, MERV 5.

9. Condensate Drain Pans: Sloped, corrosion-free drain pan. Provide with a minimum of 2” in depth. Provide with drains at each end, positioned to prevent overflow. Provide with drain pan overflow float switch, upon activation of the drain pan overflow float switch the unit shall shutdown.
10. Cabinet Leakage:
    a. Cabinet air leakage less than 2.0% at 1.0 inch H_2O when tested in accordance with ASHRAE standard 193.

B. Outdoor Units - Air-Cooled, Compressor-Condenser Components:
1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
    a. Compressor Type: Scroll.
    b. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-454B.
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with AHRI 210/240.
3. Condenser Coil: Copper tube, with mechanically bonded aluminum fins and thermal- expansion valve. Comply with AHRI 210/240. Provide Manufacturer’s seacoast protective coil coating.
4. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Wind Buffer Kit: Permits operation down to 0 deg F.
8. Mounting Base: Polyethylene

2.3 ACCESSORIES

A. Control equipment **is** specified in Division 23 Section~~s~~ "Instrumentation and Control for HVAC". Refer to contract drawings for Sequences of Operation.

B. Thermostat:
1. Low voltage with subbase to control compressor and evaporator fan.
2. Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
3. Compressor time delay.
4. 24-hour time control of system stop and start.
5. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
6. Fan-speed selection including auto setting.
7. Automatic-reset timer to prevent rapid cycling of compressor.

C. 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.

D. Drain Hose: For condensate.

E. Controller: Provide with BACnet compatible controller.

2.4 CAPACITIES AND CHARACTERISTICS

A. Refer to schedule on Contract Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:
1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 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. 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, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.3 STARTUP SERVICE

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

3.4 DEMONSTRATION

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

END OF SECTION 23 81 26

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WATER SOURCE MODULAR HEAT PUMPS

SECTION 23 81 46 - WATER SOURCE MODULAR HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of water-source heat pumps systems:
   1. Water source modular 6 pipe heat pumps capable of simultaneous heating/cooling and heat recovery.

1.2 RELATED SECTIONS

A. 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC.

B. 23 05 19 - METERS AND GAUGES FOR HVAC PIPING

C. 23 21 16 – HYDRONIC SPECIALITIES

D. 23 25 00 – HVAC WATER TREATMENT

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each model.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
   2. In addition to wiring diagrams for Power, Signal and Control, include signal and control wiring protocols used; wire types; communication speed; and if multiple layers of communication exist, provide BACnet registry for each layer as well as BACnet interface access instructions for each layer. The Water Source Modular Heat Pump Manufacturer shall provide this information to the Building Automation Contractor to coordinate seamless point to point communication for system optimization.

C. Field quality-control test reports.

D. Operation and maintenance data.

E. Special warranties.

1.4 QUALITY ASSURANCE

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

B. ASHRAE Compliance:
   1. ASHRAE 15.
   2. Applicable requirements in ASHRAE 62.1-2022, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   3. ASHRAE/IESNA 90.1-2022 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
   4. ARI/ASHRAE/ISO Standard 550/590 Chilling and Heat Pump Water-Heating Packages

C. Comply with NFPA 70.

D. UL Listing and Compliance – Units are to be designed, constructed and assembled to meet or exceed all applicable Underwriters' Laboratories' safety requirements. Units must be listed and labeled as having met UL 6035-2-40 safety standards for A2L refrigerants. Installation must comply with any additional field application requirements outlined under ASHRAE Standard 15 if applicable.

E. All units to be factory tested with water. Only performing electrical tests is not sufficient. A full performance testing and witness testing at the factory shall be included.

1.5 DELIVER, STORAGE, AND PROTECTION

A. Inspect units at the time of delivery, making note of any discrepancies or irregularities on the delivery documentation. Comply with manufacturer's rigging and installation instructions of unloading units and moving to final location for installation.

B. Protect finished cabinets from physical damage by leaving factory packing in place until installation and providing temporary covers after installation if the units are to be exposed to potential damage. Do not install units with visible cabinet or component damage repair or replace as necessary.

1.6 OWNER'S RIGHT TO REPAIR

A. The Manufacturer will supply to the owner: operating license and software to heat pump controls, version of internal communication software protocol, any necessary cabling, or unique connections for access and configuration of heat pump internal controls. Manufacturer will also provide service access credentials, access rights, and copy of system configuration files at the time of substantial completion, or at the time commissioning and testing have occurred, whichever is later. The Manufacturer shall provide owner with an additional version of the system configuration file at the end of the warranty period. Failure to provide these items at the end of the warranty period will result in liquidated damages paid by the manufacturer of $25,000 / day beyond the end of the warranty period that the software, connections, access rights, and configuration files are not turned over to the owner.

1.7 WARRANTY

WATER SOURCE MODULAR HEAT PUMPS

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace refrigeration components of water-source heat pumps that fail in materials or workmanship within five years from date of Substantial Completion, or when final Field Testing and Commissioning of equipment has been complete and accepted by Owner; whichever is later.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
      a. WaterFurnace International, Inc. TruClimate (Design Basis)
      b. Multistack
      c. ClimaCool.

2.2 WATER TO WATER HEAT PUMPS

A. Description: Factory assembled and tested, single packaged water-source modular heat pump consisting of 10-gauge welded steel frame with powder coat paint, sealed refrigerant circuit including two compressors, refrigerant to water heat exchangers, bi-directional electronic expansion valve refrigeration controls. The unit and all refrigeration components shall be rated for use with R-454B refrigerant. Field conversion of refrigerants will not be allowed.

B. General: Unit shall be able to maintain both a heating and cooling loop setpoint regardless of loads on either loop. Modules shall be able to operate to maintain all heating and cooling loads regardless of the load profile. The heat pump shall be capable of operating with a geothermal source loop.

C. Cabinet and Chassis: Galvanized-steel casing with the following features:
   1. Access panel for access and maintenance of internal components.
   2. Knockouts for electrical and piping connections.
   3. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, complying with UL 181. All insulation shall have a flame-spread index of 25 or less and a smoke-developed index of 50 or less.
   4. Frame shall be constructed of 8 gauge welded steel with forklift pockets in the bottom channel and threaded weld nuts for lifting points in the top of the frame.
   5. Enclosure shall be factory installed and constructed of heavy-gauge G60 galvanized steel coated with polyester powder coat paint.
   6. Paint shall be rated for 1,000 hour of salt spray using ASTM B117. Panels, other than control service door, shall be lined with 1/2" inch thick, foam insulation.

D. Compressors:

1. Scroll chillers use high efficiency R-454B, hermetically sealed, scroll compressors that are mounted on rubber grommets or neoprene isolators for vibration isolation. Scroll compressors provide high efficiency while providing greater tolerance to liquid refrigerant entering the suction port.
2. Compressors shall be variable speed compressors.
   a. True inverter type compressor
   b. AC drives shall not be acceptable
3. A high density sound attenuating blanket shall be factory installed to minimize compressor sound power.

E. 6-Pipe Header Rack:
1. Provide heavy gauge galvanized steel frame with electro-statically painted finish.
2. Header rack piping shall be insulated with ¾" thick, .27 BTU-in/hr sq.ft. thermal conductivity, expanded closed foam insulation.
3. The header rack can be factory mounted to the modular chiller or it can be shipped separately for ease of plumbing the mechanical room. If it is factory mounted to the chiller, all wiring to shall be done in the factory between header rack and chiller module controller. If shipped separately, contractor shall coordinate the rewiring required between the heat pump module and integral header rack sensors and switches. Additional header racks can be installed independent of the chiller to allow for future expansion of the central plant capacity.
4. 6 Pipe Standard allows a standard chiller to provide hot and chilled water simultaneously by controlling 3-way header bypass valves.
5. The header piping shall be isolated from each chiller modular using manual and modulating butterfly type water valves.
6. All wiring for water valve actuators and sensors shall use indexed type molded plug wiring harnesses for easy connection to chiller module.

F. Water Circuit:
1. The water to refrigerant heat exchangers shall be dual circuit, copper-brazed 316 stainless steel channel plates, capable of withstanding 650 psig working pressure on the refrigerant side and 450 psig on the water side.
2. Refrigerant circuits are separate with a common water supply. This provides optimal part load efficiency compared to using two single circuit heat exchangers. Heat exchangers are designed to work as an evaporator and condenser.
3. Heat exchangers are covered with 3/4" closed-cell insulation.
4. Sealed Refrigerant Circuit: Charge with R-454B refrigerant.
5. Charging Connections: Service fittings on suction and liquid for charging and testing.
6. Water Piping Connections: Each heat pump module shall have one set of entering and leaving water connections for each water circuit to the header rack. The connections shall be cast ductile iron grooved mechanical fittings conforming to ASTM A-536, Grade 65-42-12, or malleable iron conforming to ASTM A-47, Grade 32410. Grooved couplings shall be rated for use with carbon steel piping conforming to ASTM F-1476, Grade A-53B/A-106B standards. Gaskets shall be Grade "E" EPDM compound conforming to ASTM D-2000.

7. The water source modular heat pumps shall be rated to operate at the EWT and LWTs for the source, heating and chilled water loops as indicated in the heat pump schedule in the drawing package.

G. Refrigeration Components:
1. Unit shall utilize R-454B refrigerant type. All system components shall be rated to appropriate UL standards to handle maximum system pressure.
2. Factory charged, sealed system contains optimal refrigerant quantity. Contractor to coordinate with manufacturer that the unit ships with sufficient pounds of refrigerant, with any additional refrigerant procurement the responsibility of the contractor.
3. Each refrigerant circuit shall utilize a thermostatic expansion valve (TXV) or EEV with stainless steel sensing bulb and laser welded diaphragm. TXV will control adequate superheat over the stated operating range as indicated in submittal data.
4. Liquid line filter driers are to be factory installed to provide additional system cleanliness.
5. Factory installed service ports for high and low pressure readings.
6. Unit shall be provided with high and low temperature cutouts, and compressor motor overload protection. Provide capability to reset compressor lockout circuit at either remote controls or circuit breaker.
7. Refrigerant Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke- development indexes according to ASTM E 84.

H. Controls: Provide manufacturer integrated controls to cycle the units, operate efficiently and soft start the heat pumps.
1. Factory installed, wired, and functionally tested at factory before shipment.
2. Single-point power connection, or breaker rotary-type disconnect in control panel of each module.
3. Factory mounted class 2, control power transformer provides nominal 24 VAC and 120 VAC low voltage power supply. Primary to transformer is protected by Class CC fuses.
4. Provide the following safety lockout controls
   a. High pressure cut out set at 600 PSIG with manual reset.
   b. Low pressure cut out set at 40 PSIG with manual reset.
   c. Loss of charge switch
   d. Water freeze protection on both the load and source heat exchangers.
5. Unit shall have phase loss/reversal for compressor protection.
6. Individual modules shall be daisy chained together into the supervisory controller by the contractor.
7. Individual modules with have associated header rack flow switches, temperature sensors factory wired unless the header rack is shipped separately. Contractor to wire and install whatever devices are required if they choose to ship the header rack separately.

8. The factory provided bypass header valve and its associated differential pressure and temperature sensors shall be field wired to the supervisory controller by the contractor. A total of three (3) bypass headers shall be shipped with the heat pump modules.
9. Supervisory Controller:
    a. Provide manufacturer's supervisory controller capable of the flowing:
        1) Modulation of header bypass valves to maintain differential water temperature across each loop header.
    b. Provide manufacturer's on-board module controller for each module. Module controller shall be capable of the following:
        1) Modulation of four (4) heat exchanger isolation valves
        2) Modulate condenser and evaporator isolation valves to maintain delta T setpoints.
        3) Provide on board controls for each module capable of managing the compressors, electronic expansion valves, and individual I/O control points. Refer to drawings for I/O summary.
    c. The unit shall be controlled using a microprocessor which sequences all functions and modes of operations.
    d. Units shall be capable to communicate through standard DDC protocols such as BACnet/IP; BACnet MS/TP (minimum communication speed of 76,800 Baud Rate); Lon (LonTalk). Preference is BACnet/IP. The control system shall have the following features:
        1) Anti-short cycle time delay of 5 minutes on compressor operation.
        2) Start on power up mode
        3) Low voltage protection
        4) High voltage protection
        5) Unit shut down on high or low refrigerant pressures
        6) Unit shut down for freeze detection
        7) Source and Load heat exchanger freeze detection setpoint selectable for water or antifreeze. This project has a heating, cooling, and source loop with antifreeze fluid protection fluid, 25% propylene glycol.
        8) Automatic intelligent reset
    e. The units touch screen HMI shall be capable of displaying:
        1) Entering and leaving water temperature at each brazed plate heat exchanger
        2) Discharge refrigerant pressure and saturated temperature values
        3) Suction refrigerant pressure and saturated temperature values
        4) Superheat and subcooling values
        5) Electrical energy consumption
        6) Modular chiller modes and control status
        7) Modular chiller compressor accumulated runtime
    f. Coordinate all temperature control work with the DDC Controls manufacturer.
    g. Factory to provide fully functional copy and access rights of the system operating software / configuration file of the equipment.
10. The following BACnet points shall be made available to the BMS:
    a. Individual Module Information
        1) ID Number

2) Header Mode
3) Module Mode
4) Power
5) Module Status
6) Module Control (On/Off)

b. Refrigerant Circuit Sub-Controller
1) Compressor Status
2) Motor Amps (each available phase)
3) Compressor Fault Code
4) Discharge Pressure
5) Discharge Temperature
6) Suction Pressure
7) Suction Line Temperature
8) EEV Position
9) Suction Superheat Temperature
10) Motor Winding Temperature
11) Variable Speed Compressor Capacity %
12) Variable Speed Compressor RPM
13) Condenser Sub-Cooling Temperature
14) Compresser Run Hours

c. Module Electronic Expansion Valves (EEV)
1) % Open (for each EEV)

d. Module Safety and Limit Controls
1) Evaporator Freeze Protection
2) Low Suction Pressure Limit
3) High Discharge Pressure Limit
4) High Discharge Temperature Limit
5) High Motor Temperature
6) Motor Overload
7) Voltage Phase Failure

e. Setpoints
1) Chilled Water Supply Temperature Setpoint
2) Hot Water Supply Temperature Setpoint
3) CHWS Temperature Reset
4) HWS Temperature Reset

f. Water / Glycol Fluid Sensors at Header
1) Hot Fluid Inlet Temperature
2) Hot Fluid Outlet Temperature
3) Cold Fluid Inlet Temperature
4) Cold Fluid Outlet Temperature
5) Geothermal Inlet Temperature
6) Geothermal Outlet Temperature
7) Hot Fluid Loop Differential Pressure
8) Cold Fluid Loop Differential Pressure
9) Geothermal Fluid Loop Differential Pressure

g. Header Bypass Valve
1) Hot Fluid Bypass Valve Command and Position

2) Cold Fluid Bypass Valve Command and Position
3) Geothermal Fluid Bypass Valve Command and Position

h. Module Isolation Valves and Mixing / Reversing Valves
1) Isolation Valve Command and Position
2) Mixing / Reversing Valve Command and Position

I. Accessories:
1. Provide shipped loose mesh strainers with grooved connections
2. Provide all necessary end caps and hardware for connecting modules
3. Bypass Header Assembly:
a. Provide a factory supplied bypass assembly complete with a modulating control valve for minimum flow requirements for each loop (chilled water, hot water, source water). Refer to drawings for additional information.
b. Provide field wiring for header supply and return temperature to factory supplied master panel.
c. Provide field wiring for header differential pressure sensors. (one sensor for each loop, 3 total).
1) Mount all three differential pressure sensors on a board adjacent to the heat pump supervisory controller, power supply, and enclosure.
d. Note that basis of design unit includes the bypass header assembly as a factory supplied accessory. If the contractor choses to provide an alternate manufacturer, it is the responsibly of the contractor to provide a bypass header that is of equal design and function. This includes but is not limited to all piping, valves, supports, insulation and controls for a full turnkey installation. Additional cost associated with building or providing this bypass header by another manufacturer shall not be borne by the owner after the bidding process has been completed.
e. Provide loose wiring harnesses for connection to equipment, hardware access keys, software access keys, and/or port connections for system configuration and ongoing troubleshooting and maintenance of the equipment and software control system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Install water to water heat pumps on 6" concrete housekeeping pads.

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

D. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

E. Install units with adequate clearance from obstructions to allow for routine maintenance and servicing.

F. Water Piping: Connect heat pump source water supply and return piping, heating water supply and return piping, and chilled water supply and return piping to heat pump as indicated, with unions and shutoff valves. All unit supply and return piping is to be insulated. Provide field installed water stainless steel 40-mesh strainers with blow-down valves to prevent particulate debris from obstructing water flow through the water to refrigerant heat exchangers. Provide with bolted screen cover to cleaning.

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

3.2 CONNECTIONS

A. Ground Loop Water Piping: Connect supply and return piping to modular chiller bank as indicated, with unions and shutoff valves. All unit supply and return piping is to be insulated. Provide field installed water strainers to prevent particulate debris from obstructing water flow through the water to refrigerant heat exchangers.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. The heat pump source water loop, heating water loop, and chilled water loop shall be cleaned flushed and treated per the Engineer’s direction.
   2. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
   3. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   5. Test and adjust all unitary and associated equipment controls and safeties. Verify the controls are operating the base units correctly and different units are interacting correctly. Test all unit safeties and verify they trip as expected. Reset and re-do tests at least 5 times. Replace damaged and malfunctioning controls and equipment. Document all test procedures on the OPT testing forms.
   6. Provide Manufacturer’s start-up of all equipment. Provide signed documentation of all field testing to the Engineer of Record and the Commissioning Agent for review and acceptance.

B. Remove and replace any malfunctioning units and retest as specified above.

3.4 COMMISSIONING

A. Coordinate TAB final testing and documentation of equipment. Provide the services of a factory-authorized representative as required to complete start up and commissioning.

B. Perform the field tests and inspections:
   1. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements. Provide “start-up” documentation for operation and maintenance documents at project close-out.
   2. Perform final acceptance testing of the HVAC&R systems as required.

C. Once initial field tests and inspections have been completed, coordinate with building commissioning authority to provide operating capacity of the system during the field testing. The intent of the testing is to demonstrate operation at or near peak capacity for heating AND for cooling. Therefore, testing is required during two distinct seasons for owner's final acceptance. Failure to provide adequate start up and field test documentation will require the manufacturer to demonstrate system performance again, at the manufacturer's expense. This may also require an extension to warranty period.

3.5 DEMONSTRATION

A. Provide the services of a factory-authorized representative, for up to four hours, to instruct the owners personnel as specified:
   1. Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
   2. Review data in the maintenance manuals specified in Section 1.6.
   3. Schedule training with Owner, through Project Manager, with at least 21 days' advance notice.

END OF SECTION 23 81 46

SECTION 23 81 46.20 – GEOTHERMAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL PROVISIONS

A. The drawings and the general provisions of the contract, including the General Conditions, Supplementary General Conditions, and General Requirements, apply to the work of this section.

1.3 SUMMARY

A. Provide all labor, materials, equipment, and services necessary for and reasonably incidental to the furnishing and installation of the work and equipment of this section.

B. The geothermal loop field will consist of the vertical bores quantity and depth of boars are listed on the contract drawings. The high-density polyethylene (HDPE) pipe on the vertical bore shall be 1½ inch diameter. Header size is referenced in the contract drawings and will be piped in reverse return.

1.4 REFERENCES

A. International Ground Source Heat Pump Association (IGSHPA) Installation Manuals.

1. Section 8 – Installation

2. Section 9 – System testing, verification, and delivery

1.5 SUBMITTALS

A. Submittals Package: Submit product data and quality control submittals specified below at the same time as a package.

B. Product Data: Manufacturer’s catalog sheets, specifications, and installation instructions for each item specified.

1. For piping, including manufacturer’s name, schedule, type or class of pipe and fittings, and where optional materials are specified in the Pipe and Fitting schedule, indicate the option selected.

2. Provide 1/4 scale drawings of proposed layout. Drawing shall be coordinated with actual field site conditions and shall include all pipe sizes and joints.

C. Quality Control Submittals:

1. Geothermal System Installer's Qualifications Data:

a. Name of each person who will be performing the geothermal work and their employer's name, business address and telephone number.

b. Names and addresses of 3 similar projects that each person has worked on.

c. Copy of installer's personal certification for polyethylene pipe fusion techniques from IGSHPA or piping manufacturer.

2. Geothermal System Supervisor's Qualifications Data:

a. Name of person overseeing the geothermal work and their name, business address and telephone number.

b. Name and address of 3 similar projects that the supervisor has overseen during the past 5 years.

c. Copy of supervisor's personal certification for polyethylene pipe fusion techniques from IGSHPA or piping manufacturer.

3. Geothermal System Contractor's Qualifications Data.

a. Names and addresses of 3 geothermal projects of similar size and complexity that the Supplier has worked on during the past 5 years.

4. Company Field Advisor Data.

a. Name, business address and telephone number of Company Field Advisor secured for the required services.

b. Certified statement from the company listing the qualifications of the Company Field Advisor.

c. Services and each product, for which the company gives authorization, listed specifically for this project.

5. IGSHPA Installation Manuals: Submit one copy of each manual to the Engineer.

D. Contract Closeout Submittals: Warranty – Copy of specified warranty.

1.6 QUALITY ASSURANCE

A. Geothermal System Installer Qualifications: The persons performing geothermal work shall be personally certified in polyethylene pipe fusion techniques by IGSHPA or piping manufacturer, personally experienced in geothermal work, and shall have been regularly employed by a Company performing geothermal work for a minimum of 3 years.

B. Geothermal System Supervisor's Qualifications: The persons overseeing the geothermal work shall be personally certified in polyethylene pip fusion techniques by IGSHPA or piping manufacturer, personally experienced in geothermal work, and shall have been regularly employed by a Company performing general work for a minimum of 5 years.

C. Geothermal System Supplier Qualifications: The contractor shall have completed geothermal work on at least 3 projects of similar size and complexity within the last 5 years. Company Field Advisor: Secure the services of a Company Field Advisor from the Geothermal System manufacturer for a minimum of 40 working hours for the following:

1. Render advice regarding installation and final adjustment of the system.

2. Witness on site bore hole locations in the presence of the Owner's representative.

3. Certify that vertical bore holes meet design depth, and don't exceed a 5% differential in depth from one bore hole to another.

4. Witness pressure testing of horizontal and vertical underground polyethylene piping, in the presence of the Owner's representative.

5. Witness the back-filling of horizontal pipe trenches.

6. Witness final system test, then certify with an affidavit that the system is installed in accordance with the Contractor Documents and is operating properly.

D. Regulatory Requirements:

1. Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.

2. Perform field testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and as specified.

3. Coordinate with Sunny Cortland representative 48 hours before backfilling any piping or bore holes by 48 hours to allow for the campus geo locator team to identify each borehole on their system.

4. Provide time schedule of the drilling, piping installation, excavation and back filling, etc.

Coordinate with Owner Representative for witnessing, leak testing , flushing and purging and minimum of two wells drilling on opposite sides of the vault.

1.7 EQUIPMENT

A. All equipment furnished to complete the work shall be in good operating condition and capable of safely and efficiently performing the work required in a timely fashion. The Contractor shall provide qualified operating personnel for the operation of this equipment.

B. The Contractor shall furnish and install at the Contractor's own expense, all fuel, oil, hydraulic fluid, grease, cable, repair parts, including worn or broken tools, and all other supplies, bits and parts or personnel necessary for the efficient operation of each piece of equipment.

1.8 PERMITS, LAWS AND REGULATIONS

A. The Contractor shall procure and pay for all permits, licenses, inspections, or approvals necessary for the execution of the contract.

B. The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work, the protection of property, the maintaining of surface passageways to buildings, fences, and/or other facilities.

C. All applicable Federal and State laws and regulations, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over the project shall apply to the contractor throughout and they shall be deemed to be included in the contract as a part, therefor, the same as though herein written out in full.

D. All regulations of the Occupational Safety and Health Act are in effect on this contract. It will be the Contractor's responsibility to make himself aware of all appropriate County, State and Federal regulations that apply to this contract.

E. Any violations incurred from improper execution of the above shall be paid by the Contractor. Loss of time on the project from such violations will not be tolerated.

1.9 WATER SUPPLY

A. The Contractor shall supply potable water as necessary to perform the work. The equipment will include pumps, water trucks or trailers, storage tanks and all other items necessary to provide an adequate supply of potable water. The source shall be subject to approval of the Engineer.

1.10 PROJECT CONDITIONS

A. Protection: During test work, protect controls, gages and accessories which are not designed to withstand test procedures. Do not utilize permanently installed gages for field testing of systems

1.11 SEQUENCING AND SCHEDULING

A. Transmit written notification of proposed date and time of operational tests to the Owner's representative at least 5 days in advance of such tests.

B. Perform cleaning and testing work in the presence of the Owner's representative.

1.12 WARRANTY

A. Manufacturer's Warranty: Minimum 50-year warranty for polyethylene piping. 1-year warranty on the piping installation

B. Special Warranty: 25 years for butt fusion welds in polyethylene piping against leakage.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. This paragraph pertains to:

1. All underground piping for the wellfield and for the vertical boreholes.

2. All piping from well field vault shutoff valves up to and including well field.

3. The manifold inside the vault up to the isolation valve.

B. High Density Polyethylene (PE) Pipe and Fittings:

1. Engineered High Density Polyethylene (HDPE) PE 4710 DR 11 materials for water.

2. PE4710 Pipe shall be certified to the requirements of CSA B137.1, ASTM D2737, ASTM D3035, or ASTM F714.

3. PE4710 be manufactured from a PE compound that has a pipe material designation code of PE4710 when evaluated in accordance with ASTM D3350 and a color and ultraviolet stabilizer code of C or E. Code E compounds shall be stabilized against deterioration from unprotected exposure to ultraviolet rays for not less than 3 years, as evidenced by meeting the test criteria specified in AWWA C901.

4. Certified the requirements of NSF Standard 358-1

5. Certified to the requirements of NSF/ANSI/CAN 61

C. Fittings:

1. Butt fusion type: ASTM D3261

2. Socket fusion type: ASTM D2683

3. Electrofusion Type: ASTM F1055

4. Install as a “U” configuration at bottom of well with “butt fusion” techniques.

D. Acceptable Manufacturers:

1. WL Plastics

2. Geothermal Supply Company

3. Performance Pipe

E. Joining and Sealant Materials: Thread Sealant:

1. Lake Chemical Co.’s, Slic-Tite

2. Loctite Corp.’s pipe sealant with Teflon

3. Safe-T-Lok

F. Packing materials for Building Construction penetrations & Vault Wall Penetrations:

1. Mechanical Modular Seals: For wall and floor seals designed for the service of piping system in which installed.

a. GPT (Link-Seal)

b. Garlock (Link-Seal)

c. Maddock Industries (Link-Seal)

G. Valves:

1. See Specification Section 230523 for valves, as issued by the building interior systems’ Engineer.

2.2 GROUT/ SEALER:

A. Thermally enhanced bentonite grout or grout III shall be used to seal and backfill the vertical u-bend well bore to insure proper thermal contact with the earth and to ensure the environmental integrity of the vertical bore column. Once fully set (within 24 hours) the grouting material shall remain in a thick, putty-like, plastic state (moldable) throughout the life of the system and shall not generate heat during the hydration process. Utilize a tremie pipe to grout from the bottom of the bore to the top of the bore.

B. No other backfill material shall be accepted.

C. Grouting compound shall be certified and listed by the National Sanitation Foundation International (NSF) to ANSI/NSF Standard 60, “Drinking Water Treatment Chemicals – Health Effects”.

D. Materials to be utilized by the Contractor shall be Grout 111. Grout shall have a minimum thermal conductivity of 1.2 BTU/hr. ft. °f.

E. Acceptable Manufacturer:

1. GoPro Inc. TG Lite

2. Mineral Technologies

3. Geo-System USA

2.3 TESTING MATERIALS

A. Test equipment and Instruments: Type and kind as required for the particular system under test.

B. Test media (air, gas, and water): As specified for the particular piping or system being cleaned.

C. Cleaning Agent (chemical solution, water): As specified for the particular piping, apparatus or system being cleaned.

2.4 WALL SEALS

A. All piping passing through exterior walls, concrete walls, foundation walls, floor slabs shall have opening around pipe sealed with modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.

B. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall.

2.5 INSULATION

A. Insulate all interior piping and manifold piping within well field vault with foamed plastic pipe insulation with a K factor of .28 at 75 degrees Fahrenheit mean temperature. Thickness shall be 2 in. thick.

B. The insulation shall be slipped over tubing before final connection is made when possible. Preslit foamed insulation by manufacturer shall be used when installation of insulation shall be made after pipe connections. Seal all cut edges and joints with construction adhesive.

C. Flexible tubing shall be slipped over fittings where possible. Fabricate fittings from larger diameter tubing so that fitting insulation shall nest over the covering of the adjoining pipe. Adhere with construction adhesive.

D. The insulation shall be as manufactured by Imcoa, Rubatex, or as deemed equal by the Engineer.

2.6 AIR SEPARATOR

A. The air separator shall have an internal stainless steel air collector tube with 5/32 in. diameter perforations and 63% open area designed to direct accumulated air to the compression tank or air vent via an NPT vent connection at top of unit.

B. The air separator shall have a removable galvanized steel system strainer with 3/16 in. diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. The strainer shall be located at the bottom of the vessel to reduce floor space required for strainer removal.

C. A blowdown connection shall be provided to facilitate routine cleaning of the strainer and the separator.

D. Vessel shell diameter to be three times the nominal inlet/outlet pipe diameter, with a minimum vessel volume for sufficient velocity reduction. The air separator must be designed, constructed and stamped for 125 psig at 350°F in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. The air separator(s) shall be painted with one (1) shop coat of air dry enamel.

E. A manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code, shall be furnished for each air separator upon request.

F. The air separator shall be sized for a maximum pressure drop of 2 ft. wg. at full system flow rate, but the inlet and outlet sizes shall not be smaller than the line size as shown on drawings.

G. Designer Equipment: Bell & Gossett.

H. Manufacturer: Armstrong, Bell & Gossett, Patterson, Taco, Thrush, John Wood Co.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

A. Install the work of this section in accordance with the manufacturer’s printed installation instructions.

B. Prior to any excavation, trenching, or drilling, all buried utilities, drainage, and irrigation systems shall be located and flagged by the appropriate utility and contractor representatives.

C. Provide the Owner with a copy of a dimensioned site layout showing the location of the buried GSP piping relative to permanent on site structures and buried conduits.

D. The contractor shall install metallized warning tape (with printed side up) 12 in. below finished grade directly over the horizontal geothermal piping and upper ends of each well.

E. Borings:

1. If the Contractor finds it necessary to change the location or depth of any proposed borings, the Engineer shall be notified and a new location or depth shall be agreed upon.

2. If unusual conditions are encountered, including but not limited to unanticipated materials which cannot be penetrated by standard equipment, the Contractor shall immediately consult with the Mechanical Engineer.

F. Protection of Property:

1. The Contractor shall contact the Owner and all utility companies for information regarding buried utilities and structures, shall take all reasonable precautions to prevent damage to property both visible and concealed, and shall reasonably restore the site to at grade condition. Such restoration shall include, but not be limited to, backfilling of borings, patching of slabs and pavements and repair of lawns and plantings.

3.2 MOBILIZATION/DEMOBILIZATION

A. Mobilization shall consist of furnishing at the project site, labor, power, supplies, tools, equipment and performing operations in connection with the completion of the borehole and required tests.

B. Demobilization shall consist of the removal from the construction site of all plant, equipment, supplies and personnel after completion of the work including the cleanup of all rubbish, litter and waste materials generated by the Contractor's activities. Drill cuttings are not to be utilized as part of borehole construction.

3.3 PRE-DRILLING DECONTAMINATION PROCEDURES

A. Prior to arrival on-site, the drilling rig, drill rods, tools and bits shall be clean and free from potential contaminants, such as leaks, excessive grease, oils, gasoline or other substances which could be construed as much.

3.4 DRILLING MATERIALS

A. No drilling fluids other than potable water may be introduced into the borings. The boreholes shall be drilled and cleaned/purged to a depth as indicated.

B. The Contractor shall not deposit drilling waste and water within any existing stream, or in any manner which violates Local, State and Federal laws and regulations. The disposal method of all drilling waste and water must be acceptable to the Engineer and the Owner.

C. If required, a temporary casing will be installed to keep the upper consolidated materials from caving and boring. The temporary casing should be of steel, Grade B, with a minimum wall thickness of 0.280 inches, with an outside diameter 5 ½ inches or 5 3/8 inches schedule 40 PVC and be of sufficient length. This temporary casing will be pulled at the time when grouting of the boring takes place.

D. Throughout the entire project, the driller must make all attempts to keep any material that could be construed as contaminants from entering the boreholes. In the event that borehole becomes contaminated due to the neglect of the Contractor, he shall at his own expense, perform such work and supply materials as needed to eliminate the contamination.

3.5 DRILLING LOG

A. The Drilling Contractor shall maintain and submit a complete, accurate, and legible Drill Log (also referred to as a Borehole Record or Well Completion Report) for each vertical borehole heat exchanger drilled on the project site. The Drill Log is a project record document and shall be prepared in conformance with:

1. CSA/ANSI/IGSHPA C448.4:25, Clause 6.2.2 – Drill Log, and Clause 6.2 – Inspection and Documentation, as the primary governing standard.

2. IGSHPA Standard Specification for Ground Source Heat Pump Systems as a supplemental reference.

3. Applicable NY water well construction regulations, including but not limited to Environmental Conservation Law (ECL) §15-1525 and 10 NYCRR Part 75, and all requirements of the New York of Environmental Conservation / Health or equivalent agency having jurisdiction.

4. National Ground Water Association (NGWA)Manual of Water Well Construction Practices (current edition), where applicable to borehole construction practices.

5. ASTM D5092 – Standard Practice for Design and Installation of Ground Water Monitoring Wells, where geologic logging methodology is concerned.

6. All applicable local, state, and federal environmental regulations governing subsurface investigation, reporting, and groundwater protection.

B. The Drill Log shall be initiated at commencement of drilling of each borehole and continuously updated in real time during drilling operations. Retroactive completion of Drill Logs from memory is not acceptable.

C. Each Drill Log shall contain, at minimum, the following information. All entries shall be recorded in both IP (inch-pound) units.

D. The drill log will have the following:

1. Project and Borehole Identification

a. Project name, project number, and physical address.

b. Owner's name and contact information.

c. General Contractor's name and contact information.

d. Drilling Contractor's name, license or registration number, and contact information.

e. IGSHPA or NGWA certification number(s) of the on-site driller supervisor.

f. Unique borehole identification number or label (correlate to borehole layout drawing).

g. Borehole coordinates (GPS latitude/longitude and/or survey coordinates to within ±1 foot horizontal accuracy), referenced to the project site plan.

h. Ground surface elevation at borehole location (referenced to project datum or NAVD 88).

i. Date and time drilling commenced.

j. Date and time drilling was completed.

k. Date and time of U-bend assembly installation.

l. Date and time grouting was completed.

2. Borehole Physical Parameters

a. Total borehole depth drilled (feet/meters), measured from finish grade.

b. Final accepted borehole depth after clean-out or reaming (if different from drilled depth).

c. Nominal borehole diameter (inches/mm) at each interval; note any reamed or cased intervals.

d. Borehole inclination (deviation from vertical), if measured; note any significant deviation encountered.

e. Static groundwater level (depth to first water-bearing zone) measured prior to installation of loop assembly, in feet below grade.

f. Artesian conditions, if encountered (note date, time, and estimated flow rate).

3. Drilling Method and Equipment

a. Drilling method used (e.g., rotary mud, air rotary, down-hole hammer/DTH, cable tool, combination).

b. Drilling rig make, model, and identification number.

c. Drill bit type(s) and size(s) used at each interval.

d. Drilling fluid type (e.g., air, water, potable water with bentonite, biodegradable polymer); confirm fluid is non-toxic and biodegradable in compliance with CSA/ANSI/IGSHPA C448.4:25.

e. Drilling fluid additive(s), if any, with MSDS/SDS reference.

f. Casing type, material, diameter, wall thickness, and depth intervals installed, if applicable.

4. Geologic Formation Log (Lithologic Log)

a. Continuous geologic description of materials encountered at depth, recorded at intervals not exceeding five (5) feet 1.5 m, or at each formation change, whichever is more frequent.

b. Description shall include material type (soil, rock, fill); color; grain size/texture; degree of consolidation; estimated moisture content; rock hardness/RQD where applicable; and any noted features (fractures, voids, solution cavities, cobbles, boulders).

c. Identification of all water-bearing zones or aquifers encountered, including depth, thickness, and estimated yield or artesian head.

d. Note depth at which any unusual conditions are encountered, including: lost circulation, cave-ins, obstructions, gas or odor, contaminated soils, or significant changes in drilling rate.

e. Geologic classification shall follow the Unified Soil Classification System (USCS) per ASTM D2487 for soils, and standard lithologic nomenclature for rock formations.

5. Heat Exchanger Loop Installation Record

a. U-bend or loop type (single U-tube, double U-tube, coaxial) and pipe material (HDPE, SDR11 per ASTM D3350, or as specified).

b. Pipe outside diameter, wall thickness, and SDR designation.

c. Pipe manufacturer, lot number, and production date code.

d. Total pipe length installed (feet/meters) in each borehole.

e. Tremie pipe (grout pipe) diameter, material, and placement method.

f. Confirmation that U-bend was installed to the full design depth with positive stop; note actual installed depth.

g. Confirmation of pre-installation pressure test result on U-bend assembly per CSA/ANSI/IGSHPA C448.4:25, Clause 8.2 and as specified in Paragraph 3.9, including: test pressure (psi/kPa), test duration, pass/fail result, and technician signature.

6. Grouting Record

a. Grout material type (e.g., thermally enhanced bentonite grout, neat cement, sand-cement, or as specified); reference product data sheet.

b. Grout mix design: water-to-solids ratio, additives, and resulting thermal conductivity (Btu/hr·ft·°F or W/m·K) per product documentation or field test.

c. Grouting method: tremie (bottom-up), as required by CSA/ANSI/IGSHPA C448.4:25 and applicable state regulations to prevent bridging and voids.

d. Total volume of grout placed (gallons/liters) in each borehole.

e. Theoretical annular volume calculated vs. actual volume placed (note any significant discrepancy and corrective action taken).

f. Depth at which grout return was observed at surface.

g. Confirmation that grout was placed from the bottom of the borehole to finish grade (or frost depth, as specified).

h. Any grout top-off required after initial set; volume and date of top-off noted.

7. Post-Installation Pressure Test Record

a. Pressure test results after grouting and loop interconnection per CSA/ANSI/IGSHPA C448.4:25, Clause 8.2 (ASTM F2164 adapted):

1) Initial test pressure (psi/kPa).

2) Expansion phase duration.

3) Stabilization phase duration.

4) Final 60-minute test pressure (start and end).

5) Verification that pressure did not decrease by more than 5% during the last 60-minute test.

6) Pass/Fail determination and technician signature.

b. Any remediation performed and retest results.

E. Format and Submission Requirements

1. The Drill Log shall be completed on a standard form acceptable to the Owner and the AHJ.

2. The Drilling Contractor shall use athe standard Drill Log form of IGSHPA/NGWA standard borehole record form.

3. A preliminary (field) copy of the Drill Log for each borehole shall be submitted to the Owner's Representative within 24 hours of completion of that borehole's grouting.

4. A final, signed, and certified Drill Log for each borehole shall be submitted as part of the project closeout documentation within 30 days of project substantial completion, or as required by the applicable state regulatory authority, whichever is sooner.

5. Number of Copies: Submit four (4) copies in hardcopy and one (1) electronic copy (PDF, unlocked) for each borehole.

6. The Drill Log shall be included in the project Operations and Maintenance (O&M) Manual and submitted to the applicable state regulatory agency if required by law.

3.6 DRILLING SAMPLING:

A. The drilling contractor shall allow the campus Geotech department to obtain sample of the drilling outcome as needed for their internal researches and testing.

3.7 INSTALLATION - PIPING

A. General Piping Installation

1. This Contractor shall provide as shown on the drawings a complete system of piping, all valves as indicated or as necessary. The piping drawings are diagrammatic and indicate the general location and connections. The piping may have to be offset, lowered or raised as required or as directed at the site.

2. Piping shall be properly supported and adequate provisions shall be made for expansion, contractions, slope and anchorage. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be placed without springing or forcing, property clearing all interferences. All pipes shall have burr and cutting slag removed by reaming or other cleaning methods.

3. All piping shall be arranged so as not to interfere with removal of other equipment or devices nor to block access. All valves and specialties shall be placed to permit easy operation and access, and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. Piping shall be installed so as to avoid liquid or air pockets throughout the work.

B. Underground Horizontal Piping:

1. Install piping in pipe trenches after cushion material bedding has been placed and completed.

a. Minimum Pipe Depth: 60 in. below finished grade. If ledge rock is encountered, 2 in. insulation board may be placed over headers if finished grade is below 48 in. this must be approved by the engineer prior to installation of insulation board.

b. Insulate piping at wall penetrations.

2. Separate supply and return lines or bundles a minimum of 12 inches to minimize thermal interference.

3. Minimize the number of points where supply and return lines cross one another.

4. Install piping of such lengths to minimize the number of fusion joints required.

5. Avoid sharp bends in piping, use elbows where required.

6. Install bell reducing fittings or reducing tees at pipe reductions to eliminate trapped air.

7. Cap open end of pipe to prevent entry of contaminants until final connections are made.

8. Pressure test piping after connecting to vertical well piping. Test as specified in Paragraph 3.9 Pipe Cleaning and Testing.

C. Underground Vertical Piping:

1. The holes or bores shall be clean and of sufficient diameter to facilitate the installation of the U-tube assembly. Extreme care shall be taken not to crush, cut or kink the pipe. If damaged, it shall be repaired, at no additional cost to the Owner.

2. Remove all cutout material remaining in well from drilling process before installing well piping.

3. Vertical Piping shall be factory assembled:

   a. Manufacturer shall construct down-hole closed-loop piping from two continuous lengths of pipe with U-bend joints at the bottom of the well.

   b. Manufacturer shall hydrostatically test the assembled vertical piping at 1-1/2 times the maximum working pressure, but not less than 125 psig, for four hours.

   c. Manufacturer shall cap piping assembly before shipment.

4. Provide fittings required for pressure testing.

5. Immediately after insertion into well, fill piping with water until it runs clear. The water in piping is intended to counteract the buoyancy effect. Attach additional counterweights as necessary to bottom of piping for deep wells.

6. Cap upper ends of well piping until connection to horizontal manifold is made.

7. Cap open end of pipe to prevent contaminants from entering until final connections are made.

8. Grouting: The grout will be a slurry that will termie grouted from the bottom of the boring to the surface in accordance with the IGSHPA installation manual. The Contractor will work quickly to assure that there are not air voids forming as a result of the Grout 111 placing.

9. Connect vertical piping to horizontal manifolds and pressure test entire underground system as specified in Paragraph 3.9, Cleaning and Testing, before back filling trenches.

D. Pipe Joint Makeup:

1. Polyethylene Butt or Saddle (side wall) Fusion Pipe Joints: Follow the manufacturer's printed installation instructions.

2. Dissimilar Pipe Joints:

a. Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.

b. Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.

3.8 INSTALLATION - EQUIPMENT

A. The fusion machine shall encompass the following feature:

1. Guide rods shall be in the plans that passes through the centerline of the pie, thus canceling the bending forces in the machine cause by the fusion forces.

2. The combination butt/saddle machine must have a mechanical advantage of at least 5.5 to 1 in the butt fusion mode, and 2.5 to 1 in the saddle fusion mode. A butt fusion only machine must have a mechanical advantage of at least 600 lbs. of thrust.

3. The pipe clamps shall have the strength to "round-up" the pipe close to the fusion joint. They must be adjustable for removal of high/low mismatch of pipe walls, and clamp each piece on a continuing straight centerline.

4. The pipe facing device shall be capable of rapid facing of the pipe ends to a perfectly flat surface, so when the ends are brought together, there is 100% plastic contact. The facer shall be hand-powered for pipe sizes up to 2 in., electrically powered up to 8 in., and hydraulically powered for sizes larger than 8 in.. The facer shall have precisely machined stops to lock the facer squarely between the clamping jaws at the end of face off.

5. The heater plate shall be electrically heated and thermostatically controlled. The surface shall be smooth with a high-quality non-stick coating. The heater shall be capable of quick heat-up and maintaining a constant surface temperature in the desired temperature range even in inclement conditions. The heater plate shall be equipped with a thermometer to monitor proper temperature.

3.9 PIPE CLEANING AND TESTING

A. Preliminary Work: Thoroughly clean pipe and tubing prior to installation. During installation, prevent foreign matter from entering systems. Prevent if possible or remove obstructions from piping and systems.

B. Flushing, Purging, Pressure and Flow Testing:

C. All fusion joints and loops lengths shall be checked to verify that no leaks have occurred in shipping or in fusion joining.

D. All loops will be pressure tested before installation, and all horizontal components of the ground well field/geothermal underground/heat exchanger will be pressure tested prior to back-filling.

E. The geothermal underground piping/heat exchanger, up to and including main shutoff valves within the building mechanical room, will be tested hydrostatically at the smaller of 150% of the pipe design rating or 300% of the new system operating pressure. Do not test until every joint has set and cooled at least 8 hours. Maintain test pressure for 24 hours. Record trench temperature at start and finish of pressure test. There shall be no reduction in applied test pressure other than that due to a change in ambient temperature. Use test gage with on psi increment and readable to 1/2 psi.

F. Cleaning: Flush systems and apparatus, upon completion of pressure and miscellaneous tests. Completely open valves and flush each system with clean water, prior to chemical cleaning. Repeatedly flush at short intervals until twice the system water capacity has been flushed through. Chemically clean systems immediately following flushing operations. Circulate a solution consisting of trisodium phosphate, in a proportion of one pound of chemical every 50 gallons of water in the system. Completely fill system with cleaning solution, vent system and place in operation, with automatic controls operating and valves fully open. Allow system to reach design operating temperature. Circulate the solution through the system for a minimum of 4 consecutive hours; immediately drain matches and clean water input. Keep strainers unplugged during cleaning operations. Remove and clean strainer screens prior to operational test. Refill system with clean water.

G. Flow rates and pressure drops will be compared to calculated values to ensure that there is not blockage or kinking of any pipe.

H. A minimum velocity of 2 ft./sec in each piping section must be maintained for a minimum of 15 minutes to remove all air. A change of more than one inch in the level of fluid in the purge pump tank during pressurization indicates air still trapped in the system.

I. The contractor shall flush, clean and chemically treat the piping after installation prior to burring the pipe. And again, piping to be flushed prior to equipment startup.

3.10 SITE CONDITIONS

A. Clean up work on the site shall be a daily activity. The Contract should not leave any type of trash or refuse of any sort on the site at any time.

B. Final clean-up must be completed prior to final inspection and acceptance of the work. No refuse of any variety shall be buried on the site. The Contractor will dispose of all drill cuttings off of the site.

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SECTION 23 82 14 - CHILLED BEAMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Active chilled beams.

1.2 ACTION SUBMITTALS

A. Product Data: For chilled beams.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chilled beams.
2. Operating weight and dimensions of assembled units.
3. Performance data, including water-tube, airflow, water pressure drop, and air-side pressure drop, noise and air velocities.
4. Construction details, including materials of construction and fastening methods.
5. Certified ETL Independent test data for air heating and cooling performance, throw and sound for each terminal.

B. Shop Drawings: For chilled beams.
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.

C. Product Schedule: For chilled beams

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Shipped chilled-beam products with similar requirements to those indicated for a continuous period of five years within time of bid.
2. Chilled-beam products that have been successfully tested and in use on at least five completed projects.

3. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
4. Having full-time in-house employees for the following:
   a. Product research and development.
   b. Product and application engineering.
   c. Product manufacturing, testing, and quality control.
   d. Technical support for system installation training, startup, commissioning, and troubleshooting.
   e. Owner training.

B. Mockups: Build mockups to set quality standards for materials and execution.
1. Build mockups to show a finished installation for each of the following applications:
   a. For each different chilled beam type indicated on Drawings.
2. Mockups shall be fully operational.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Condensate Pump Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. Capacities and Characteristics: See schedules.

2.2 ACTIVE CHILLED BEAMS

A. Basis of Design: NuClimate Air Quality Systems

B. Available manufacturers offering products that may be incorporated into the Work include the following:
1. Semco.
2. Carrier.
3. York.

C. Source Limitations: Obtain chilled beams from single manufacturer.

D. Description: Sheet metal casing with primary-air, secondary-air, and mixed-air plenums; air nozzles; air inlet grille; supply-air discharge slot(s); cooling and heating] hydronic coil assembly; and mounting brackets; and accessories suitable for location and mounting arrangement indicated on Drawings.

E. Components:
   1. Casing:
      a. Materials, Exposed Units: Minimum 20-gauge thick, galvanized-steel sheet.
      b. Materials, Recessed Units: Minimum 20-gauge thick, galvanized-steel sheet.
      c. Mounting Brackets: Factory installed along long side of units, with not less than four supports located near corners of units; field adjustable.
      d. Commissioning Ports: Equip chilled beams with commissioning ports for field measurement of static pressure differential between primary-air plenum and room. Include an airflow calibration chart attached to each chilled beam.
      e. Casing Leakage: Factory seal casing joints, seams, and penetrations of casing positive-pressure plenums to be airtight. Leakage in primary-air plenum shall not exceed 5 percent of airflow rate indicated on Drawings.
      f. Primary-Air Plenum Duct Connections: Round or oval collar of sufficient length to accommodate a slip-on field-installed duct. Size as indicated on Drawings
      g. Insulation: Exterior or interior portions of casing capable of forming surface condensation shall be insulated with mineral-fiber, fiber glass or armaflex elastomeric insulation to prevent condensation.

   2. Air Nozzles: Quantity, size, and arrangement selected by chilled-beam manufacturer for performance indicated on Drawings. Primary air supplied through nozzles shall induce room (secondary) air across hydronic coil, and two air steams shall mix to supply conditioned air to room.
      a. Material: Plastic, complying with NFPA 90A and UL 94 V-0.
      b. Field replaceable with different size nozzles to accommodate changes to performance.

   3. Inlet Air Grille: Mounted on face of chilled beam and arranged for room (secondary) air to enter grille and hydronic coil before mixing with primary air.
      a. Perforated face with a minimum 50 percent free area.
      b. Multi fin diffusers with a minimum 50 percent free area.
      c. Hinged on one sides to open from room side.
      d. Removable from room side.

   4. Supply-Air Discharge Slot(s): Size and arrangement selected by chilled-beam manufacturer for performance indicated on Drawings.
      a. Material: Extruded aluminum or formed steel.
   5. Hydronic Coil: Copper tube mechanically bonded to aluminum fins and mounted in a galvanized-steel coil casing; rated for minimum working pressure of 300 psig.
      a. Tube Thickness: Minimum 0.016-inch.
      b. Fluid Tube Velocity (at Chilled-Water Design Flow Rate):
         1) Maximum: 6 fps
         2) Minimum: 1 fps
      c. Fin Thickness: Minimum 0.006-inch thick.
      d. Fin Spacing: No closer than 11 fins per inch.
      e. Field Piping Connections: Solder or Threaded ends with terminations oriented for field connection, as indicated on Drawings.
      f. Piping Arrangement: Two pipe.

g. Include coil with manual air vent and drain fitting with valve.
h. Include coil face with removable lint screen that is easily accessible for inspection and cleaning from room side.
i. Include drain pan constructed of 304 stainless steel with a ¾" drain connection. Extension collars shall be included so that the elevation from the center of the drain connection to the bottom of the unit is elvated allowing condensate drain to be piped. Drain panel shall be sloped for no standing water and be a minimum of 2" in depth. The end drain connection shall be a welded copper fitting desing.

6. Factory Piping: ASTM B88, Type L copper tube with ASME B16.22 wrought-copper fittings.

F. Finish: Baked enamel or powder coat.
1. Color: Manufacturer's standard or custom paint color, as selected by Architect.
2. Appearance of Finished Work: Variations in same piece are unacceptable.

G. Accessories:
1. Primary Airflow Automated Dampers: Modulating inlet damper with low-voltage electric actuator for connection to external controls.
2. Primary Airflow Manual Dampers: Integral damper assembly with locking handle for field adjustment.
3. Primary Airflow Regulators: Factory set to airflow rate indicated on Drawings; capable of maintaining constant airflow rate within 10 percent of set point.
4. Condensate Pump: Provide with a condensate pump with a minimum 10' of total dynamic head at 25 gallons per hour.
5. Condensate Drain Pan Float Switch: Provide one unit per zone with a condensate drain pan float switch to be tied into the building management system, as described in the Controls Drawings M643.

H. Source Quality Control: Comply with ASHRAE 200, AHRI 1240, and AHRI 1241.
1. Rate capacity of coils in accordance with AHRI 410, with capacities established in accordance with ASHRAE 200.

2.3 GENERAL PROTECTION REQUIREMENTS

A. Protect finishes on exposed surfaces from damage by applying a removable, temporary protective covering at the factory before shipping.

B. Protect coil and piping openings with removable end caps before shipping.

C. Protect duct connection openings with removable end caps before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive chilled beams for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for duct, piping and wiring to verify actual locations of connections before installation.

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

3.2 INSTALLATION OF CHILLED BEAMS

A. Install chilled beams level and plumb.

B. Coordinate layout and installation of chilled beams and suspension-system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communications system, security system, and partition assemblies.

C. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

D. Install continuous-thread hanger rods of size required to support chilled-beam weight. Laterally brace chilled beams to prevent movement.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for general-duty valves specified in Section 230523 "General-Duty Valves for HVAC Piping."

C. Make piping connections to chilled-beam units at locations indicated on Drawings.

D. Where installing piping adjacent to chilled beams, allow space for service and maintenance.

3.4 DUCT CONNECTIONS

A. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts." and Section 233346 "Flexible Ducts." Drawings indicate general arrangement of ductwork.

B. Make ductwork connections to chilled-beam units at locations indicated on Drawings.

C. Where installing ductwork adjacent to chilled beams, allow space for service and maintenance.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Comply with NECA 1.

D. Wiring Method: Install concealed cables in raceways and cable trays. Do not install cable within consoles, cabinets, desks, and counters. Do not conceal raceways and cables in unfinished spaces.
   1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems.
   2. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.6 CONTROLS

A. Comply with requirements for controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC and Section 230993.11 "Sequence of Operations for HVAC DDC."

3.7 IDENTIFICATION

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

B. Identify hydronic piping and valves. Comply with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 CLEANING AND PROTECTION

A. Protect exposed surfaces of chilled beams from damage with factory-installed protective covering. Maintain covering in place until start of unit testing and balancing.

B. Protect chilled beam water connections with factory-installed protective covers, and keep them covered until making final field piping connections.

C. Protect chilled-beam air connections with factory-installed protective covers and keep them covered until making final field duct connections.

D. Clean chilled beams inside and out to a factory-new condition.

E. Reject damaged chilled beams and replace with new units.

F. Only if acceptable to the Owner, minor damage to finishes may be repaired as required to restore beams to factory-new appearance. Any variation in visual appearance between factory and repaired finish shall be rejected.

3.9 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 tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:
1. Leak Test: After installation, fill system with water under design pressure and test for leaks. Repair leaks and retest until no leaks exist.

E. Chilled beam will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.10 ADJUSTING

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

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain chilled beams.

END OF SECTION 23 82 14

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SECTION 23 82 16.11 - HYDRONIC AIR COILS

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. Hydronic air coils.

B. Related Requirements:
   1. Section 23 21 13 - HYDRONIC PIPING.
   2. Section 23 07 19 - HVAC PIPING INSULATION.
   3. Section 23 21 16 - HYDRONIC PIPING SPECIALTIES.

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 each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig and 300 deg F.

D. Cooling coils shall have no moisture carryover at design conditions. Provide moisture eliminators on discharge face of cooling coil if necessary to eliminate moisture carryover.

E. Hot-Water Coil Capacities and Characteristics:
   1. See Schedules.

F. Chilled-Water Coil Capacities and Characteristics:
   1. See Schedules.

2.2 HYDRONIC AIR COILS

A. Manufacturers:
   1. Hot-Water and Cold-Water coils will be installed as a replacement to existing coils, in an existing Daikin fan coil unit. Provide Daikin coils as scheduled to provide a 1:1 replacement. If a substitution for the Daikin coils is made the related rework, coordination and design will be the sole responsibility of the contractor.

B. Source Limitations: Obtain hydronic coils from single source from single manufacturer.

C. Description: Coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into the coil fins; self-venting; counterflow design of air to fluid. The only coils related to this specification are the replacement coils for FC-2.

D. Tubes:
   1. Material: Copper.
   2. Nominal Diameter: Minimum 5/8 inch before expanding, selected to provide performance indicated.
   3. Nominal Wall Thickness: As required by performance, minimum 0.020 inch thick.
   4. Return Bends: 180-degree bends; material, wall thickness, and nominal diameter to match tubes.
   5. Fluid Velocity at Design Flow Rate:
      a. Cooling Coil: 2.10 ft/s.
      b. Heating Coil: 2.70 ft/s.
   6. Features: Cleanable and Individually drainable.

E. Fins:
   1. Type: Plate.
   2. Materials:

      a. Aluminum: .00750” thick.
   3. Spacing:
      a. Cooling Coil: 7 fins per inch
      b. Heating Coil: 13 fins per inch

4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
5. Configuration: Fin type as required by performance requirements.
6. Fin and Tube Joint: Mechanical bond or silver brazed.

F. Headers:
1. Material: Carbon steel.
2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced-header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
4. Drains: Include low point of supply header with a NPS 1/2 drain connection.
5. Vents: Include high point of return supply and return header with a NPS 1/2 Insert pipe size vent connection.
6. Supply and Return Connections: Carbon steel pipe; threaded, same end of coil.
7. Protect opening of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into coil.
8. Fluid Velocity at Design Flow Rate: Maximum of 6 fps (1.8 m/s).

G. Casings and Tube Sheets:
1. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch beyond face of fins on both entering and leaving sides.
2. Materials:
   a. Galvanized steel, ASTM A653/A653M, G90 coating.

H. Top and Bottom Casings:
1. Per Manufacturer.

I. End Tube Sheets:
1. Per Manufacturer.

J. Intermediate Tube Sheets:
1. Per Manufacturer.

K. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

L. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 316 stainless steel.

M. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:
1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).

N. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

O. Coating: None.

2.3 MATERIALS

A. Aluminum: ASTM B209.

B. Copper Tube: ASTM B75/ASTM 75M annealed temper or ASTM B280 drawn temper.

C. Copper Sheet: ASTM B152.

D. 90/10 Cupronickel Alloy: ASTM B122/ASTM B122M.

E. Steel:
1. Pipe Connections: ASTM A53/A53M.

2.4 SOURCE QUALITY CONTROL

A. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than 300-psig internal pressure.

B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless steel drain pan under each cooling coil.
1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.

3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

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

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923.11 "Control Valves," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

END OF SECTION 23 82 16.11

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SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductless fan coil units, 2-pipe cooling and heating changeover coil.
   2. Ductless fan coil units, 2-pipe cooling only coil.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale and coordinated with each other based on input from installers of the items involved:

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS, 2-PIPE COOLING AND HEATING CHANGEOVER COIL

A. Manufacturer:
1. Basis of Design: ENVIRO-TEC
2. Available manufacturers offering products that may be incorporated into the Work include the following:
a. Price.
b. Trane.

B. Fan Coil Unit Configurations: Row split.
1. Changeover Coil: 4 Row, 10 Fins per inch.

C. Coil Section Insulation:
1. 1/2-inch-thick, coated glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
2. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Drain Pans: Main and Auxiliary, Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.

E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.

G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
1. MERV Rating: 8 when tested according to ASHRAE 52.2.
2. Glass Fiber throwaway.

H. Hydronic Changeover Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 150 deg F. Include manual air vent and drain valve.

I. Fan and Motor Board: Removable.
1. Fan: Forward curved, 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 230500 "Common Work Results for HVAC."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

J. Hydronic Piping Package: ASTM B88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Fed from six-way, control valves for dual-temperature coil.
2. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
a. Length: 24 inches.
b. Minimum Diameter: Equal to fan coil unit connection size.
3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
5. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
6. Wrought-Copper Unions: ASME B16.22.

K. 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."

L. Terminal Controller: BacNET compatible DDC controller.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

N. Capacities and Characteristics:
1. See Schedule

2.3 DUCTLESS FAN COIL UNITS, 2-PIPE COOLING ONLY COIL

A. Manufacturer:
1. Basis of Design: ENVIRO-TEC
2. Available manufacturers offering products that may be incorporated into the Work include the following:
a. Price.
b. Trane.

B. Fan Coil Unit Configurations: Row split.
1. Number of Cooling Coils: One with two-pipe system.

C. Coil Section Insulation:

1. 1/2-inch-thick, coated glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
2. Insulate coil section according to Section 230716 "HVAC Equipment Insulation."
3. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.

E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.

G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
1. MERV Rating: 8 when tested according to ASHRAE 52.2.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

I. Fan and Motor Board: Removable.

1. Fan: Forward curved, 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 230500 "Common Work Results for HVAC."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

J. Factory, Hydronic Piping Package: ASTM B88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Two-way, two-position control valve for hot-water heating coil.
2. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
   a. Length: 24 inches.
   b. Minimum Diameter: Equal to fan coil unit connection size.
3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
5. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
6. Wrought-Copper Unions: ASME B16.22.

K. 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."

L. Terminal Controller: BacNET compatible DDC controller.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

N. Capacities and Characteristics:
1. See schedules.

PART 3 - EXECUTION

3.1 INSTALLATION OF FAN COIL UNITS

A. Install fan coil units level and plumb.

B. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548.13 "Vibration Controls for HVAC Piping and Equipment."

C. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches above finished floor.

D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

E. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
   a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 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. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.3 ADJUSTING

A. Adjust initial temperature and humidity set points.

END OF SECTION 23 82 19

SECTION 23 82 36 – BASEBOARD RADIANT PANEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydronic, baseboard radiation panels.

1.3 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 details and dimensions of custom-fabricated enclosures.
   4. Indicate location and size of each field connection.
   5. Indicate location and arrangement of piping valves and specialties.
   6. Indicate location and arrangement of integral controls.
   7. Include enclosure joints, corner pieces, access doors, and other accessories.
   8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

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. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
   2. Method of attaching finned-tube radiation heaters to building structure.
   3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HOT-WATER BASEBOARD RADIATIANT PANELS

1. Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include the following:
   a. Runtal
   b. Myson
   c. Ecostyle

B. Performance Ratings: Rate baseboard radiation heaters according to Hydronics Institute's "IBR Testing and Rating Standard for Baseboard Radiation."

C. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on polypropylene element glides. Tube ends shall be threaded.
1. Tube Diameter: NPS 1/2.
2. Fin Size: Fins attached to enclosure shall be sized per the manufacturer.
3. Fin Spacing: No less than 32 per foot.
4. Number of Tiers: See schedule.
5. Heat Output: See schedule.
6. Continuing Water Temperature: See schedule.
7. Average Water Temperature: See schedule.

D. Enclosures: Minimum 0.09” thick steel, removable front cover.
1. Full-height back.
2. Full-length damper.
3. End panel.
4. End caps.
5. Inside and outside corners.
6. Valve access door.
7. Joiner pieces to snap together.
8. Enclosure Height: See schedule.
9. Enclosure Depth: See schedule.
10. Finish: Baked-enamel finish in manufacturer's custom color as selected by Architect.
11. Element Brackets: Primed and painted steel to support front panel and element.
12. Provide filler pieces/blanks as required to fill radiant panels wall to wall, up to corners and to cover pipe risers/drops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 BASEBOARD RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall, where specified on drawings.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

J. Use filler pieces/blanks as required to fill radiant panels wall to wall, up to corners and to cover pipe risers/drops.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
   1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

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

C. Prepare test and inspection reports.

END OF SECTION 23 82 36

SECTION 23 82 39.13 - CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

1.2 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.

1.3 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Basis of design: Sterling
   2. Available manufacturers offering products that may be incorporated into the Work include the following:
      a. Sigma Corp
      b. Modine
      c. Zehnder

2.2 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.

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 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
   1. Horizontal Unit, Exposed Bottom Panels: Galvanized steel, removable panels secured with tamperproof cam fasteners and safety chain.
   2. Recessed Flanges: Steel, finished to match cabinet.
   3. Control Access Door

2.5 FILTERS

A. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.

B. Material: Pleated cotton-polyester media, MERV 5.

2.6 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

2.7 CONTROLS

A. Fan and Motor Board: Removable.
   1. Fan: Forward curved, 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. Terminal Controller: BacNET compatible DDC controller.

C. 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."

2.8 CAPACITIES AND CHARACTERISTICS

A. Cabinet:
   1. Horizontal, Fully Recessed:
      a. Air Inlet: Front.
      b. Air Outlet: bottom louver.

B. Vertical, Fully Recessed:
   1. Air Inlet: Front bottom.
   2. Air Outlet: Front top.

C. Fan:
   1. Airflow: Refer to schedule.
   2. Motor Horsepower: Refer to schedule.

D. Heating Capacity:
   1. Output: Refer to schedule.
   2. Entering-Air Temperature: Refer to schedule.

E. Hot-Water Heating Coil:
   1. Water Flow: Refer to schedule.
   2. Water-Side Pressure Loss: Refer to schedule.
   3. Entering-Water Temperature: Refer to schedule.

F. Filters:

1. Thickness: 1 inch.

G. Electrical Characteristics for Single-Point Connection:
1. Volts: Refer to schedule.
2. Phase: Refer to schedule.
3. Hertz: Refer to schedule.
4. Motor Amperes: Refer to schedule.

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 piping and electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall-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.

B. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 "Hydronic Piping Specialties". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater per pipe hookup diagram. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. 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 with the assistance of a factory-authorized service representative:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. 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.

END OF SECTION 23 82 39.13

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SECTION 23 82 39.19 - CEILING AND WALL MOUNTED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Wall and ceiling unit heaters with propeller fans and hydronic heating coils.

1.2 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 details of anchorages and attachments to structure and to supported equipment.
   4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 WALL AND CEILING MOUNTED UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Basis of design: Sterling
   2. Available manufacturers offering products that may be incorporated into the Work include the following:
      a. Sigma Corp
      b. Modine
      c. Zehnder

2.2 DESCRIPTION

A. Heaters: Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

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

2.3 CABINET

A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with custom color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230500 "Common Work Results for HVAC."

2.6 CONTROLS

A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

B. Terminal Controller: BacNET compatible DDC controller.

C. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS

A. Airflow: Refer to schedule.

B. Fan Speed: Refer to schedule.

C. Heating Coil: Refer to schedule.

D. Electrical Characteristics for Single-Point Connection:

1. Volts: Refer to schedule.
2. Phase: Refer to schedule.
3. Hertz: Refer to schedule.
4. Full-Load Amperes: Refer to schedule.

PART 3 - EXECUTION

3.1 INSTALLATION OF WALL AND CEILING UNIT HEATERS

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. 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.

D. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 39.19

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SECTION 26 05 05 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition.

1.2 SUBMITTALS

A. Not required.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate electrical outages with Campus well in advance of any shutdown. Outages will be expected to be performed in the evenings and/or weekends, as directed by the Campus.

C. Provide temporary wiring and connections to maintain existing systems and existing circuits which are not scheduled for removal, in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service. Disable system only to make switchovers and connections as illustrated on the single line diagrams. Minimize outage duration.

1. Make temporary connections as illustrated on the single line diagrams.

E. Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Notify SUNY before partially or completely disabling system.

2. Campus will notify their local supervisory station.

3. Make notifications at least 48 hours in advance.

4. Make temporary connections to maintain service in areas adjacent to work area.

5. Provide temporary heat detectors as shown on the contract drawings.

F. Existing Telephone/Data/Camera/CCTV Systems: Maintain existing systems in service, except where extensions or removals are identified on the Contract Drawings. .

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:

1. PCB- and DEHP-containing lighting ballasts.

2. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

L. Items to be Turned Over to Owner: Carefully remove and turn over to the Campus, at a location on campus directed by the Campus, the following existing items, undamaged:

1. Fire alarm initiating devices, notification appliances, control panel, annunciators and auxiliary head-end equipment, where indicated on the removal drawings.

2. Network clocks and security cameras impacted by the work (turn over to SUNY Cortland Network Services).

3. Variable frequency drives, starters and disconnects serving pumps and equipment removed under other Divisions, where the Campus requests them.

4. Other items indicated on the drawings to be turned over to the Campus.

M. Before removal, review the list with the Campus. Dispose of items the Campus declines, in accordance with applicable regulations.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

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SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Medium-voltage (15 kV class) shielded power cable.

B. Medium-voltage cable terminations and splices.

C. Field testing of medium-voltage cables.

D. Scope: Permanent primary cables from the existing 15 kV S&C sectionalizing switch to the new cast-coil unit substation transformer primary, re-termination of existing campus loop cables at the relocated sectionalizing switch, and temporary primary cables to the temporary transformer during construction phasing (Tasks 1 through 3), as indicated on the drawings.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 33.13 - Conduit for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems.

D. Section 26 05 73 - Power System Studies.

E. Section 26 12 16.11 - Dry-Type, Cast-Coil, Medium-Voltage Transformers.

1.3 REFERENCE STANDARDS

A. AEIC CS8 - Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV; Current Edition.

B. ICEA S-93-639/NEMA WC 74 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy; Current Edition.

C. IEEE 48 - Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV; Current Edition.

D. IEEE 400.2 - Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) (less than 1 Hz); Current Edition.

E. IEEE 404 - Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV; Current Edition.

F. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 1072 - Medium-Voltage Power Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate cable installation, terminations and energization with the Campus, including campus 13.2 kV loop outages and the phasing indicated on the drawings. Notify the Campus in advance of each outage as required by Division 01.

B. Do not energize cables until field tests are complete and test reports have been reviewed by the Engineer.

1.5 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Product Data: Cable, terminations, splices and accessories.

C. Installer Qualifications: Name and training records of each person who will make medium-voltage terminations and splices.

D. Factory Test Reports: Certified production test reports per ICEA S-93-639 and AEIC CS8.

E. Field Test Reports: Results of all field tests, including test voltages, durations and leakage readings.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Installer Qualifications: Terminations and splices made by persons trained by the termination manufacturer for the kits used, with a minimum of three years of documented experience terminating 15 kV shielded cable.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver cable on reels with cable ends sealed. Store reels on a firm surface off the ground and protect from damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cable: Okonite Company; Southwire Company; Prysmian Group (General Cable); Kerite (Marmon).

B. Terminations and Splices: 3M; TE Connectivity (Raychem); Richards Manufacturing.

2.2 MEDIUM-VOLTAGE CABLE

A. Single conductor, shielded, listed and labeled as Type MV-105 complying with UL 1072, ICEA S-93-639/NEMA WC 74 and AEIC CS8.

B. Voltage Rating: 15 kV.

C. Insulation Level: 133 percent.

D. Conductor: Class B compressed stranded annealed copper; sizes as indicated.

E. Conductor Shield: Extruded semiconducting layer.

F. Insulation: Ethylene propylene rubber (EPR), 220 mils nominal.

G. Insulation Shield: Extruded semiconducting layer, free-stripping.

H. Metallic Shield: Helically applied 5 mil copper tape with overlap.

I. Jacket: PVC or CPE, sunlight resistant, suitable for wet locations.

J. Grounding Conductor: As indicated on the drawings (insulated 600 V copper run with the primary cables).

2.3 TERMINATIONS

A. IEEE 48 Class 1, indoor, cold-shrink or heat-shrink type with integral stress control, sized for the cable, with provision for grounding the cable shield.

B. Lugs: Long-barrel, two-hole copper compression lugs.

2.4 SPLICES

A. Splices are not permitted in permanent cables. Where approved by the Engineer for temporary cables, provide IEEE 404 cold-shrink splices.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that raceways are complete, clean and free of burrs before pulling cable.

3.2 INSTALLATION

A. Install cables in rigid metal conduit as indicated, in accordance with the manufacturer's instructions.

B. Do not exceed the manufacturer's maximum pulling tension and sidewall pressure. Use pulling lubricant compatible with the cable jacket.

C. Minimum Bending Radius: Twelve times the cable overall diameter, or the manufacturer's minimum if larger.

D. Ground the metallic shield at each termination unless otherwise indicated.

E. Identify phases with colored tape at each termination, and tag cables per Section 26 05 53.

F. Existing Campus Loop Cables: Where the existing 15 kV sectionalizing switch is relocated, maintain or extend the existing cables as indicated; provide new termination kits for any cable that is re-terminated.

G. Temporary Cables: Install, test and remove temporary primary cables as indicated on the phasing drawings, to the same requirements as permanent cables.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, Section 7.3.3 (medium-voltage cables), except Section 4.

B. After installation and termination and before energization, perform shield continuity, insulation resistance and VLF withstand tests per IEEE 400.2 at acceptance test levels on each new cable.

C. Re-terminated existing cables: Perform VLF withstand tests at maintenance test levels.

D. Notify the Engineer and the Campus at least seven days before testing. Submit test reports before energization.

E. Replace cables, terminations or splices that fail testing, and retest.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Metal-clad cable.

C. Wiring connectors.

D. Electrical tape.

E. Wire pulling lubricant.

F. Cable ties.

G. Fire Rated Cable Assembly

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

C. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

G. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification; 2008a (Validated 2013).

H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

I. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.

J. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.

K. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

N. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

O. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Most Recent Edition, Including All Revisions.

P. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

Q. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

R. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

S. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

T. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

B. Field Quality Control Test Reports.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted, except as temporary panelboard feeders where indicated on the phasing drawings. Remove temporary cable when the permanent installation is complete.

F. Armored cable is not permitted.

G. Metal-clad cable is permitted only as follows:

1. MC cable is only to be used for final connections to 20A branch circuits, and only where specific permission has been granted by SUNY in writing. Seek approval prior to use.

2. In addition to other applicable restrictions, may not be used:

a. Where exposed to view.

b. Where exposed to damage.

c. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide new conductors and cables manufactured not more than one year prior to installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Comply with FS A-A-59544 where applicable.

G. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

H. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

I. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

J. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.

3. Tinned Copper Conductors: Comply with ASTM B33.

K. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.

a. Exceptions:

1) 20 A, 120 V circuits longer than 100 feet: 10 AWG, for voltage drop.

2) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.

2. Control Circuits: 14 AWG.

L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

M. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.

a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.

3. Color Code:

a. 480Y/277 V, 3 Phase, 4 Wire System:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

4) Neutral/Grounded: Gray.

b. 208Y/120 V, 3 Phase, 4 Wire System:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

4) Neutral/Grounded: White.

c. Equipment Ground, All Systems: Green.

d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

e. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:

1. Copper Building Wire:

a. Cerro Wire LLC

b. Encore Wire Corporation

c. General Cable Technologies Corporation

d. Southwire Company

B. Description: Single conductor insulated wire.

C. Conductor Stranding:

1. Feeders and Branch Circuits:

a. Size 10 AWG and Smaller: Solid.

b. Size 8 AWG and Larger: Stranded.

2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:

1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.

a. Installed Underground: Type XHHW-2.

2.4 METAL-CLAD CABLE

A. Manufacturers:

1. AFC Cable Systems Inc

2. Encore Wire Corporation

3. Southwire Company

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

1. Size 10 AWG and Smaller: Solid.

2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide oversized neutral conductors.

G. Grounding: Full-size integral equipment grounding conductor.

H. Armor: Steel, interlocked tape.

I. Provide PVC jacket applied over cable armor.

2.5 FIRE RATED CABLING ASSEMBLIES

A. MI: AFC Cable Systems' Type MI Cable, or Pentair Pyrotenax Mineral Insulated System 1850 Pyrotenax Cable:

1. Copper conductors.

2. Seamless copper sheath

3. 2 hour fire resistive rating UL system classified, listed in UL building materials directory product category electrical circuit protective systems (FHIT), or Fire resistive cables (FHJR)

4. 600 Volt Rated

5. Fittings and accessories as required for a complete system to suit listing and installation conditions

6. Equipment Grounding and Bonding with MI Cable:

a. Feeder F230 (480 V, fire pump disconnect to T-FP primary): The MI cable copper sheath may serve as the equipment grounding conductor (NFPA 70, 250.118) only where the cable manufacturer confirms in writing that the sheath ground-fault current path is rated for the 600 A overcurrent device protecting the feeder. Otherwise,

provide an insulated copper equipment grounding conductor sized per NFPA 70 Table 250.122.

b. Feeder F405 (208 V, T-FP secondary to fire pump controller): Provide a separate insulated 1/0 AWG copper supply-side bonding jumper from the T-FP system bonding point to the fire pump controller ground bus, in accordance with NFPA 70, 250.30(A)(2) and 250.102(C). Bond the MI sheath at both ends; do not rely on the sheath as the bonding path.

c. Terminate MI cable with listed fittings and glands suitable for the equipment enclosures, maintaining sheath continuity and bonding.

2.6 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:

1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.

2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.

2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.

4. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

5. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.

6. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

F. Push-in Wire Connectors: Rated 600 V, 221 degrees F.

G. Mechanical Connectors: Provide bolted type or set-screw type.

H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.7 ACCESSORIES

A. Electrical Tape:

1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

a. Product: Scotch Super 33+.

b. Substitutions: See Division 01 product requirements.

2. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.

a. Product: Scotch 130C.

b. Substitutions: See Division 01 product requirements.

B. Wire Pulling Lubricant:

1. Listed and labeled as complying with UL 267.

2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.

3. Suitable for use at installation temperature.

C. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Install conductors in raceways after the raceway system is completed. Exceptions: Type MI, or other type specifically indicated on the drawings not to be installed in raceways

B. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.

2. When circuit destination is indicated without specific routing, determine exact routing required.

3. Arrange circuiting to minimize splices.

4. Include circuit lengths required to install connected devices within 10 ft of location indicated.

5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.

6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.

7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.

8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

C. Install products in accordance with manufacturer's instructions.

D. Perform work in accordance with NECA 1 (general workmanship).

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Install Fire Rated Cable Assemblies in strict accordance with the manufacturer's recommendations and as detailed in the UL guidance.

G. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.

2. Pull all conductors and cables together into raceway at same time.

3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

I. Terminate cables using suitable fittings.

1. Metal-Clad Cable (Type MC):

a. Use listed fittings.

b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

J. Install conductors with a minimum of 12 inches of slack at each outlet.

K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

N. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.

2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.

3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

1. Dry Locations: Use insulating covers specifically designed for the connectors.

2. Damp Locations: Use insulating covers specifically designed for the connectors.

a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.

P. Insulate ends of spare conductors using vinyl insulating electrical tape.

Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

R. Identify conductors and cables in accordance with Section 26 05 53.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods approved by UL.

T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Provide follow-up thermographic survey.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for conductors larger than #2. The resistance test for parallel conductors listed as optional is not required.

1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

B. Field quality control test reports.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.

2. Grounding Electrode System: Not greater than 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

F. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
    a. Provide continuous grounding electrode conductors without splice or joint.
    b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Ground Ring:
    a. Provide a ground ring encircling the Generator consisting of bare copper conductor 3/0 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
    b. Provide connection from ground ring conductor to:
        1) Perimeter columns of generator frame.
        2) Ground rod electrodes, one at each corner of the ring (four total), 3/4 inch by 10 feet copper-clad, unless otherwise indicated.
3. Ground Rod Electrode(s) for Building Ground System
    a. Provide two electrodes unless otherwise indicated or required.
    b. Space electrodes not less than 10 feet from each other and any other ground electrode.
    c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
4. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
5. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
    a. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

G. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.

2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:

   a. Transformers (except autotransformers such as buck-boost transformers).

   b. Generators, when neutral is switched in the transfer switch.

2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.

5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.

6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

7. 480 V Unit Substation (cast-coil transformer secondary, 480Y/277 V): Bond the neutral (XO) to the equipment ground bus with the system bonding jumper at the transformer only; the neutral is not distributed beyond the transformer. Connect the grounding electrode conductor at the same point to building steel and metal water piping, and to the electrical room ground bar (EGB).

8. Fire Pump Transformer T-FP (480 V delta to 208Y/120 V): Provide the supply-side bonding jumper to the fire pump controller as specified in Section 26 05 19 for MI feeder F405.

I. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.

4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

7. Provide bonding for metal building frame.

J. Communications Systems Grounding and Bonding:

1. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.

a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.

b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.

c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.

2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:

1. Use insulated copper conductors unless otherwise indicated.

a. Exceptions:

1) Use bare copper conductors where installed underground in direct contact with earth.

2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

a. Exceptions:

1) Use exothermic welded connections for connections to metal building frame.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.

2. Size: As indicated.

3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.

2. Material: Copper-bonded (copper-clad) steel.

3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.

5. Manufacturers:

a. allG Fabrication

b. Galvan Industries, Inc

c. Harger Lightning & Grounding

d. nVent ERICO

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.3 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 7.13.

C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

C. Section 26 51 00 - Lighting: Additional support and attachment requirements for interior luminaires.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.

2. Coordinate work to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.

4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.

5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.

a. NFPA 70.

b. Requirements of authorities having jurisdiction.

2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.

3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use products for applications other than as permitted by NFPA 70 and product listing.

6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.

    a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated or specified on the Drawings. Supports shall match the materials of the equipment required to be supported.

    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.

2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

D. Metal Channel/Strut Framing Systems:

1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.

2. Comply with MFMA-4.

3. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.

4. Channel Material:

    a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.

    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.

5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.

6. Minimum Channel Dimensions: 1-1/2 inch width by 1-5/8 inch height.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

1. Minimum Size, Unless Otherwise Indicated or Required:

a. Equipment Supports: 1/2-inch diameter.

b. Busway Supports: 1/2-inch diameter.

c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.

d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.

e. Trapeze Support for Multiple Conduits: 3/8-inch diameter.

f. Outlet Boxes: 1/4-inch diameter.

g. Luminaires: 1/4-inch diameter.

F. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.

1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.

2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

G. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

4. Hollow Masonry: Use toggle bolts.

5. Hollow Stud Walls: Use toggle bolts.

6. Steel: Use beam clamps, machine bolts, or welded threaded studs.

7. Sheet Metal: Use sheet metal screws.

8. Plastic and lead anchors are not permitted.

9. Powder-actuated fasteners are not permitted.

10. Hammer-driven anchors and fasteners are not permitted.

11. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

    a. Manufacturer: Same as manufacturer of metal channel/strut framing system.

    b. Comply with MFMA-4.

    c. Channel Material: Use galvanized steel.

    d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Equipment Support and Attachment:

1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.

2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 3 inches in height; see Section 03 30 00.

5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: See Section 26 05 33.13 for additional requirements.

J. Box Support and Attachment: See Section 26 05 33.16 for additional requirements.

K. Interior Luminaire Support and Attachment: See Section 26 51 00 for additional requirements.

L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

M. Secure fasteners in accordance with manufacturer's recommended torque settings.

N. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Flexible metal conduit (FMC).

C. Liquidtight flexible metal conduit (LFMC).

D. Galvanized steel electrical metallic tubing (EMT).

E. Rigid polyvinyl chloride (PVC) conduit.

F. Conduit fittings.

G. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1. Includes additional requirements for fittings for grounding and bonding.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 33.16 - Boxes for Electrical Systems.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.

G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

K. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

L. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

N. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

O. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

P. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.

3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.

4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.

5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

B. Shop Drawings:

1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.

C. Project Record Documents: Record actual routing for conduits installed underground and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Refer to the Raceway Schedule on the Electrical Drawings for permitted usage and restrictions.

C. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

D. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).

1. Maximum Length: 6 feet.

E. Flexible Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit (FMC).

2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).

3. Maximum Length: 6 feet unless otherwise indicated.

F. Fished in Existing Walls, Where Necessary: Use flexible metal conduit or MC cable (where permission given by campus).

2.2 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.

C. Fittings for Grounding and Bonding: See Section 26 05 26 for additional requirements.

D. Provide conduit, fittings, supports, and accessories required for complete raceway system.

E. Provide products listed, classified, and labeled as suitable for purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4 inch (21 mm) trade size.

2. Branch Circuit Homeruns: 3/4-inch trade size.

3. Underground, Exterior: 1-inch trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC OR GRS)

A. Manufacturers:

1. Allied Tube & Conduit

2. Republic Conduit

3. Wheatland Tube, a Division of Zekelman Industries

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.

2. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, a division of Atkore International

2. Electri-Flex Company

3. International Metal Hose

B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

C. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:

1. AFC Cable Systems, a division of Atkore International

2. Electri-Flex Company

3. International Metal Hose

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

2.6 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International
2. Nucor Tubular Products
3. Wheatland Tube, a division of Zekelman Industries

B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
3. Connectors and Couplings: Use compression/gland or set-screw type.
   a. Do not use indenter type connectors and couplings.

2.7 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

1. ABB; Carlon
2. Allied Tube & Conduit, a division of Atkore International
3. Cantex Inc

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.8 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

D. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1.

C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

D. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.

E. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.

3. Conceal conduits unless specifically indicated to be exposed.

4. Conduits in the following areas may be exposed, unless otherwise indicated:

a. Electrical rooms.

b. Mechanical equipment rooms.

c. Within joists in areas with no ceiling.

5. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

6. Arrange conduit to maintain adequate headroom, clearances, and access.

7. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.

8. Arrange conduit to provide no more than 150 feet between pull points.

9. Route conduits above water and drain piping where possible.

10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.

11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.

12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:

a. Heaters.

b. Hot water piping.

c. Flues.

13. Group parallel conduits in same area on common rack.

F. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.

2. Provide vibration isolation where conduits connect to vibrating equipment. Seismic restraints are not required for this project.

3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

5. Use conduit strap to support single surface-mounted conduit.

a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.

6. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.

7. Use conduit clamp to support single conduit from beam clamp or threaded rod.

8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.

9. Use of spring steel conduit clips for support of conduits is not permitted.

10. Use of wire for support of conduits is not permitted.

11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

G. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.

2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.

3. Use suitable adapters where required to transition from one type of conduit to another.

4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.

5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.

7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.

8. Secure joints and connections to provide mechanical strength and electrical continuity.

H. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.

2. Make penetrations perpendicular to surfaces unless otherwise indicated.

3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.

4. Conceal bends for conduit risers emerging above ground.

5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.

6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.

8. Provide metal escutcheon plates for conduit penetrations exposed to public view.

9. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 13 - Penetration Firestopping.

I. Underground Installation:

1. Minimum Cover, Unless Otherwise Indicated or Required:

   a. Underground, Exterior: 18 inches.

2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length.

3. Refer to Burial Details on Electrical Drawings for additional details.

4. Concrete-Encased Duct Banks (DB-01 and duct banks indicated on the duct bank schedules):

   a. Conduit: Rigid PVC, Schedule 40, unless otherwise indicated. Transition to galvanized steel rigid metal conduit elbows where conduits rise into buildings or structures.

   b. Encasement: Concrete with minimum 3,000 psi compressive strength, minimum 3 inches of concrete around and between conduits. Color the top 2 inches of encasement red.

   c. Spacers: Nonmetallic duct bank spacers at intervals not exceeding 5 feet; secure duct bank against flotation during the pour.

d. Reinforcing: Where indicated on the drawings.

e. Minimum Cover: As indicated, but not less than 24 inches to top of encasement.

f. After installation, pull a mandrel 1/4 inch smaller than the conduit inside diameter and a wire brush through each duct, then install a pull string. Replace ducts that do not pass.

5. Handholes (HH designations on drawings): Polymer concrete, open bottom, set on 6 inches of compacted crushed stone, rated ANSI/SCTE 77 Tier 15 in non-traffic areas and Tier 22 where subject to vehicles. Cover marked "ELECTRIC" or "COMMUNICATIONS" as applicable; size as indicated.

J. Conduit Sealing:

1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:

a. Where conduits enter building from outside.

b. Where service conduits enter building from underground distribution system.

c. Where conduits enter building from underground.

d. Where conduits may transport moisture to contact live parts.

2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:

a. Where conduits pass from outdoors into conditioned interior spaces.

b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

K. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

L. Provide grounding and bonding; see Section 26 05 26.

M. Identify conduits; see Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Boxes and enclosures for integrated power, data, and audio/video.

D. Floor boxes.

E. Underground boxes/enclosures.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 33.13 - Conduit for Electrical Systems:

1. Conduit bodies and other fittings.

2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 27 26 - Wiring Devices:

1. Wall plates.

2. Floor box service fittings.

3. Poke-through assemblies.

4. Additional requirements for locating boxes for wiring devices.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.

G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. SCTE 77 - Specification for Underground Enclosure Integrity; 2013.

J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

L. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

M. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

N. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.

5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to preserve insulation integrity.

7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.

8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.

B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Project Record Documents: Record actual locations for cabinets and enclosures, floor boxes, and underground boxes/enclosures.

D. Maintenance Materials: Furnish the following for SUNY's use in maintenance of project.

1. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

3. Provide products listed, classified, and labeled as suitable for the purpose intended.

4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.

2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

3. Use cast iron boxes where exposed galvanized steel rigid metal conduit is used.

4. Use nonmetallic boxes where exposed rigid PVC conduit is used.

5. Use suitable concrete type boxes where flush-mounted in concrete.

6. Use suitable masonry type boxes where flush-mounted in masonry walls.

7. Use raised covers suitable for the type of wall construction and device configuration where required.

8. Use shallow boxes where required by the type of wall construction.

9. Do not use "through-wall" boxes designed for access from both sides of wall.

10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.

12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.

13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.

15. Minimum Box Size, Unless Otherwise Indicated:

a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

b. Communications Systems Outlets: Comply with Drawings and Details.

c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.

2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:

a. Indoor Clean, Dry Locations: Type 1, painted steel.

b. Outdoor Locations: Type 3R, painted steel.

3. Junction and Pull Boxes Larger Than 100 cubic inches:

a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:

a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.

5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used. Refer to Details on Contract Drawings for Basis of design and intent.

E. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.

2. Manufacturer: Same as manufacturer of floor box service fittings.

F. Underground Boxes/Enclosures:

1. Refer to drawing details for both Polymer and Concrete style boxes.

2. Applications:

a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.

b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use Concrete handholes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible. Coordinate access panels, where required, with architect.

2. Unless dimensioned, box locations indicated are approximate.

3. Locate boxes as required for devices installed under other sections or by others.

a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.

b. Communications Systems Outlets: Comply with Section 27 05 00.

4. Locate boxes so that wall plates do not span different building finishes.

5. Locate boxes so that wall plates do not cross masonry joints.

6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.

8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.

9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.

    a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.

10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.

I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

N. Underground Boxes/Enclosures:

1. Install enclosure on gravel base, minimum 6 inches deep.

2. Flush-mount enclosures located in concrete or paved areas.

3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.

4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

O. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 13 - Penetration Firestopping.

Q. Close unused box openings.

R. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

S. Provide grounding and bonding in accordance with Section 26 05 26.

T. Identify boxes in accordance with Section 26 05 53.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface raceway systems.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1. Includes metal channel (strut) used as raceway.

C. Section 26 05 33.13 - Conduit for Electrical Systems.

D. Section 26 05 33.16 - Boxes for Electrical Systems.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 27 26 - Wiring Devices: Receptacles.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.

D. UL 5A - Nonmetallic Surface Raceways and Fittings; Current Edition, Including All Revisions.

E. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 and conduit provided under Section 26 05 33.13 as required for installation of raceways provided under this section.

3. Verify minimum sizes of raceways with the actual conductors and components to be installed.

4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install raceways until final surface finishes and painting are complete.

2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.

1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

B. Shop Drawings:

1. Pre-wired Surface Raceway Systems: Provide plan and elevation views including dimensioned locations of wiring devices and circuiting arrangements.

2. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 SURFACE RACEWAY SYSTEMS

A. Manufacturers:

1. Hubbell Incorporated

2. MonoSystems, Inc

3. Wiremold, a brand of Legrand North America, Inc

B. Surface Metal Raceways: Listed and labeled as complying with UL 5.

C. Multioutlet Assemblies: Listed and labeled as complying with UL 111.

D. Surface Nonmetallic Raceways: Listed and labeled as complying with UL 5A.

E. Metal Channel (Strut) Used as Raceway: Comply with Section 26 05 29.

F. Surface Raceway System:

1. Raceway Type: As indicated on the drawings: single-channel painted steel (Wiremold V700 series or equal), or dual-channel nonmetallic (Wiremold 5000 series or equal) where indicated for combined power and data.

2. Length: As indicated on the drawings.

3. Color: To be selected by Architect.

4. Accessory Device Boxes: Suitable for the devices to be installed; color to match raceway.

5. Integrated Device Provisions:

a. Receptacles:

1) Configuration: As indicated on the drawings.

2) Color: Match raceway.

3) Spacing: As indicated on the drawings.

b. Communications Outlets:

1) Voice and Data Jacks: As specified in Section 27 05 00.

2) Configuration: As indicated on the drawings.

3) Spacing: As indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.

C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install raceways plumb and level.

D. Secure and support raceways in accordance with Section 26 05 29 at intervals complying with NFPA 70 and manufacturer's requirements.

E. Close unused raceway openings.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Identify raceways in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Inspect raceways for damage and defects.

B. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.

C. Correct wiring deficiencies and replace damaged or defective raceways.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 PROTECTION

A. Protect installed raceways from subsequent construction operations.

END OF SECTION

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 27 05 36 - Cable Trays for Communications Systems: Additional identification requirements for cable tray systems.

C. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Panelboards:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Transformers:

1) Identify kVA rating.

2) Identify voltage and phase for primary and secondary.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Identify load(s) served. Include location when not within sight of equipment.

c. Enclosed switches, circuit breakers, and motor controllers:

1) Identify voltage and phase.

2) Identify power source and circuit number. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

d. Transfer Switches:

1) Identify voltage and phase.

2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

3) Identify load(s) served. Include location.

4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

2. Service Equipment:

   a. Use identification nameplate to identify each service disconnecting means.

   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:

   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.

   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

4. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

5. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.

   a. Service equipment.

6. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.

7. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.

8. Medium-Voltage Equipment: Provide "DANGER - HIGH VOLTAGE - KEEP OUT" warning signs on 15 kV equipment enclosures and on entrances to rooms containing exposed 15

kV parts, per NFPA 70, 110.34(C). Identify medium-voltage cables at each termination, pull box and handhole with circuit designation, phase and voltage.

9. Fire Pump Disconnecting Means: Mark "FIRE PUMP DISCONNECTING MEANS" in letters not less than 1 inch high, and provide a placard adjacent to the fire pump controller stating the location of the disconnecting means and the location of the key, per NFPA 70, 695.4(B)(3).

10. Optional Standby System Equipment (NFPA 70, Article 702; ATS-SB, SBLB and downstream standby panels): Identify with text "STANDBY". At the main switchboard, provide a nameplate identifying the type and location of the on-site emergency and standby power sources.

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.

2. Identification for Communications Conductors and Cables: Comply with Section 27 05 00.

3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:

a. At each source and load connection.

b. Within boxes when more than one circuit is present.

c. Within equipment enclosures when conductors and cables enter or leave the enclosure.

5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

D. Identification for Raceways:

1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.

2. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.

a. Maximum Intervals: 20 feet.

b. Color-Coded Bands: Use Pre-Painted Conduit to mark bands 3 inches wide.

1) Color Code:

(a) Emergency Power System: Orange .

(b) Fire Alarm System: Red.

3. Use underground warning tape to identify underground raceways.

E. Identification for Boxes:

1. Use voltage markers to identify highest voltage present.

2. Use voltage markers or color coded boxes to identify systems other than normal power system.

a. Color-Coded Boxes: Field-painted in accordance with the Division 09 painting sections per the same color code used for raceways.

3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

a. For exposed boxes in public areas, use only identification labels.

F. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 27 05 00.

2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.

3. Use identification label to identify fire alarm system devices.

a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.

4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.

a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.

G. Identification for Luminaires:

1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:

    a. Indoor Clean, Dry Locations: Use plastic nameplates.

    b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.

2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.

3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.

5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.

    a. Use only for indoor locations.

2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.

2. Legend:

    a. System designation where applicable:

        1) Emergency Power System: Identify with text "EMERGENCY".

        2) Fire Alarm System: Identify with text "FIRE ALARM".

    b. Equipment designation or other approved description.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height:

    a. System Designation: 1 inch.

b. Equipment Designation: 1/2 inch.

c. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.

5. Color:

a. Normal Power System: White text on black background.

b. Emergency Power System: White text on red background.

c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.

2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/4 inch.

5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.

2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/2 inch.

5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Power source and circuit number or other designation indicated.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Black text on clear background.

G. Format for Control Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Load controlled or other designation indicated.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Designation indicated and device zone or address.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl self-laminating type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

C. Minimum Size:

1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.

2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.

3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

D. Legend:

1. Markers for Voltage Identification: Highest voltage present.

2. Markers for System Identification:

a. Emergency Power System: Text "EMERGENCY".

E. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:

1. Tape for Buried Power Lines: Black text on red background.

2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:

1. Materials:

a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.

2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.

3. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.

3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.

2. Flush-Mounted Equipment: Inside of equipment door.

3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.

4. Elevated Equipment: Legible from the floor or working platform.

5. Branch Devices: Adjacent to device.

6. Interior Components: Legible from the point of access.

7. Conduits: Legible from the floor.

8. Boxes: Outside face of cover.

9. Conductors and Cables: Legible from the point of access.

10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

I. Provide and affix a typewritten circuit directory card with a clear plastic cover to the inside of each panelboard door. Directory shall include the Panel ID, voltage rating, and current rating of the panel, as well as the circuit names (or spare circuit breakers or spare positions identified) fed by each circuit position on the panel.

3.3 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

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SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.

1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

1.3 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

B. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).

G. NEMA MG 00001 - Motors and Generators; 2024.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.

2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Submit study reports prior to or concurrent with product submittals.

2. Do not order equipment until matching study reports and product submittals have both been evaluated by Engineer.

3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

C. Scheduling:

1. Arrange access to existing facility for data collection with SUNY.

2. Where work of this section involves interruption of existing electrical service, arrange service interruption with SUNY.

1.5 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Study preparer's qualifications.

C. Study reports, stamped or sealed and signed by study preparer.

D. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Include characteristic time-current trip curves for protective devices.

2. Include impedance data for busway.

3. Include impedance data for engine generators.

4. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

5. Identify modifications made in accordance with studies that:

a. Can be made at no additional cost to SUNY.

b. As submitted will involve a change to the contract sum.

E. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

F. Site-specific arc flash hazard warning labels.

G. Field quality control reports.

H. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

I. Project Record Documents: Revise studies as required to reflect as-built conditions.

1. Include hard copies with operation and maintenance data submittals.

2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.6 POWER SYSTEM STUDIES

A. Scope of Studies:

1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).

2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.

a. Known Operating Modes:

1) Utility as source.

2) Generator as source.

3) Temporary construction configurations (Tasks 1 through 3) indicated on the phasing drawings, including the temporary 13.2 kV to 208Y/120 V transformer and temporary switchgear.

B. General Study Requirements:

1. Comply with NFPA 70.

2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:

1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.

a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.

1) Obtain up-to-date information from Campus.

b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.

c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.

d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.

e. Protective Devices:

1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).

2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.

g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

2. Existing Installations:

a. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.

D. Short-Circuit Study:

1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.

2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:

   a. Maximum utility fault currents.

   b. Maximum motor contribution.

   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:

1. Comply with applicable portions of IEEE 242 and IEEE 399.

2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.

F. Arc Flash and Shock Risk Assessment:

1. Comply with NFPA 70E.

2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.

3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:

   a. Maximum and minimum utility fault currents.

   b. Maximum and minimum motor contribution.

   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Fire Pump Motor-Starting Analysis: Analyze starting of the existing 60 HP fire pump motor at locked-rotor current, with fire pump transformer T-FP as specified in Section 26 22 00, on utility source and on generator source. Show that the voltage at the fire pump controller line terminals

does not drop more than 15 percent below the controller rated voltage while the motor starts (NFPA 70, 695.7). Report results and any recommended changes.

H. Medium-Voltage Primary Protection: Include the existing campus 15 kV S&C switch protective device (fuse or relay) that serves the new cast-coil unit substation. Obtain the existing fuse type and rating or relay settings from the Campus. Recommend a fuse size or settings that protect the transformer per NFPA 70, 450.3(A), ride through transformer inrush, and coordinate with the MSB main and the upstream campus protection.

I. Temporary Configuration Settings: Before the temporary transformer and temporary switchgear (Task 1) are energized, submit protective device settings for the temporary transformer primary and secondary devices and temporary feeders, coordinated with the campus 15 kV protection. Provide arc flash labels for the temporary equipment.

J. Breaker Size Confirmation: Confirm the generator output breaker and enclosed circuit breaker frame and trip sizes indicated on the drawings before that equipment is ordered, and report any changes needed.

K. Study Reports:

1. General Requirements:

a. Identify date of study and study preparer.

b. Identify study methodology and software product(s) used.

c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.

d. Identify base used for per unit values.

e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.

f. Include conclusions and recommendations.

2. Short-Circuit Study:

a. For each scenario, identify at each bus location:

1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).

2) Fault point X/R ratio.

3) Associated equipment short circuit current ratings.

b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3. Protective Device Coordination Study:

a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.

b. For each graph include (where applicable):

1) Partial single-line diagram identifying the portion of the system illustrated.

2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.

3) Conductors: Damage curves.

4) Transformers: Inrush points and damage curves.

5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.

6) Motors: Full load current, starting curves, and damage curves.

7) Capacitors: Full load current and damage curves.

c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.

1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.

2) Include ground fault pickup and delay.

3) Include fuse ratings.

4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.

d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Risk Assessment:

a. For the worst case for each scenario, identify at each bus location:

1) Calculated incident energy and associated working distance.

2) Calculated arc flash boundary.

3) Bolted fault current.

4) Arcing fault current.

5) Clearing time.

6) Arc gap distance.

b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

1.7 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

1. Products:

a. EasyPower LLC: www.easypower.com/#sle.

b. ETAP/Operation Technology, Inc: www.etap.com/#sle.

c. SKM Systems Analysis, Inc: www.skm.com/#sle.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

1. Materials: Comply with Section 26 05 53.

2. Minimum Size: 4 by 6 inches.

3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.

a. Include orange header that reads "WARNING" unless otherwise indicated.

b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.

c. Include the following information:

1) Arc flash boundary.

2) Available incident energy and corresponding working distance.

3) Nominal system voltage.

4) Equipment identification.

5) Study preparer, report reference, and date calculations were performed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 05 53.

3.2 FIELD QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Adjust equipment and protective devices for compliance with studies and recommended settings.

D. Notify Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.

END OF SECTION

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SECTION 26 05 83 - WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 05 33.13 - Conduit for Electrical Systems.

C. Section 26 05 33.16 - Boxes for Electrical Systems.

D. Section 26 27 26 - Wiring Devices.

E. Section 26 28 16.16 - Enclosed Switches.

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

2. Determine connection locations and requirements.

B. Sequencing:

1. Install rough-in of electrical connections before installation of equipment is required.

2. Make electrical connections before required start-up of equipment.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MATERIALS

A. Disconnect Switches: As specified in Section 26 28 16.16 and in individual equipment sections.

B. Wiring Devices: As specified in Section 26 27 26.

C. Flexible Conduit: As specified in Section 26 05 33.13.

D. Wire and Cable: As specified in Section 26 05 19.

E. Boxes: As specified in Section 26 05 33.16.

F. Motor Rated Switches - Provide as scheduled, submit product data for Engineer Review.

2.2 EQUIPMENT CONNECTIONS

A. Refer to Contract Drawings for Various connection schedules applicable to this section.:

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.

B. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:

C. Certificates of readiness

D. Certificates of completion of installation, prestart, and startup activities.

E. O&M manuals

F. Test reports

1.6 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer’s calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to coordination during the commissioning process.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each contractor.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5□F and a resolution of + or - 0.1□F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional/Functional Checklists for all commissioned components, equipment, and systems

B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into

the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been mad by the Contractor.

D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the Contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session

3.2 CONTRACTOR'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for Owner’s Responsibilities

B. Perform commissioning tests at the direction of the CxA.

C. Attend construction phase controls coordination meetings.

D. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

G. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-upand task completion for owner. Distribute preliminary schedule to commissioning team members.

H. Update schedule as required throughout the construction period.

I. Assist the CxA in all verification and functional performance tests.

J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.

L. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

M. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.

N. Participate in, and schedule vendors and contractors to participate in the training sessions.

O. Provide written notification to the Owner and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.

1. Electrical equipment including switchgear, panel boards, motor control centers, lighting, receptacles, dimmers and all other equipment furnished under this Division.

2. Emergency generators, ATS switches and emergency power systems.

3. Fire alarm system

P. The equipment supplier shall document the performance of his equipment.

Q. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.

R. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.

2. Assist in equipment testing per agreements with contractors.

3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

S. Refer to Division 01 Section “General Commissioning Requirements” for additional Contractor responsibilities.

3.3 OWNER’S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for Owner’s Responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for Design Professional’s Responsibilities.

3.5 CXA'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s Responsibilities.

3.6 TESTING PREPARATION

A. Certify in writing to the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.7 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.8 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CA.

B. Electrical Instrumentation and Control System Testing: Test lighting control, metering and BMS interface points (including the WattStopper LMOR-102 relay interfaces, switchboard meters and unit substation alarms) as specified in the individual Division 26 sections, together with the Division 23 controls contractor. Assist the CxA with preparation of testing plans.

C. Emergency Generator Testing and Acceptance Procedures: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

D. Fire Detection and Alarm System Testing: Provide technicians, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Electrical Distribution System Testing: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested

F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation.

G. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

a. Lighting Controls

b. Occupancy Sensors

c. Pull The Plug Test

d. Unit substation, main switchboard MSB and switchboard MDPL (metering, alarms and protective device settings)

e. Engine generator, transfer switches ATS-LS and ATS-SB, and the load-shed and fire pump priority sequence specified in Section 26 36 00

f. Generator docking stations and load bank

g. Fire alarm and emergency responder radio coverage systems: support the Fund's fire and life safety commissioning

3.9 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.10 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.11 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.12 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.13 TRAINING OF OWNER PERSONNEL

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

END OF SECTION

SECTION 26 09 23 - AUTOMATIC LIGHTING CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Extent of lighting control equipment Work is indicated by Drawings.

B. Types of lighting control equipment specified in this section include the following:

1. Analog Devices

a. Wall Mount Occupancy/Vacancy Sensors

b. Low Voltage Momentary Switches

c. Power Packs

2. Digital Devices

a. Digital Room Controllers

b. Digital Occupancy/Vacancy Sensors

c. Digital Switches/Dimmers

d. Digital Daylight Sensors

3. Emergency Bypass/Shunt Relays

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's data on control equipment and components.

B. Shop Drawings: Submit layout Drawings of control equipment and components.

C. Wiring Diagrams: Submit wiring and/or schematic diagrams for control equipment and components showing control and interconnection wiring, including connections to equipment components and electrical power feeders. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

D. Maintenance Manuals: Furnish maintenance manuals that contain equipment cuts, operating instructions, troubleshooting procedures, and spare parts list for equipment. Ensure manual includes operating instructions in addition to instructions for maintenance of the system.

E. Factory Commissioning & Startup

1. Provide commissioning personnel resume's and experience for approval. Personnel shall have fully commissioned at least 5 systems in the past 24 months.

2. Submit final commissioning report.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of control equipment and ancillary equipment, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least five successfully completed projects of similar scope.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the Authority Having Jurisdiction and NEC as applicable to construction, installation of lighting control and communications equipment.

2. UL Compliance: Provide lighting control equipment and components that are UL-listed and labeled.

3. NEMA Compliance: Comply with applicable requirements of NEMA's Stds Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."

4. 2025 Energy Conservation Construction Code of New York State (ECCCNYS), Section C405.2; functional testing and closeout documentation per Section C408.3.

5. ANSI/ASHRAE/IESNA 90.1 requirements.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver control equipment and components in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store control equipment in original packaging and protect from weather and construction traffic.

C. Handle control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide indoor lighting control equipment that meets or exceeds the requirements outlined in this specification.

1. Basis of Design - Legrand Wattstopper, Inc.

2. Or-equals not permitted. Sole source: the system must match and integrate with the WattStopper DLM lighting control system installed in the 2017 phase of work.

2.2 INTERIOR LIGHTING CONTROL DEVICES - ANALOG

A. General: Provide factory fabricated occupancy/vacancy sensor controls consisting of passive infrared and/or ultrasonic motion which scans an area in search of changes in temperature and/or motion caused by the presence, or absence, of people within the desired viewing area. When no presence is detected for a period of up to 20 minutes, the lights are switched off.

B. Dual Technology Wall Mounted Sensors

1. Unit shall have minimum 180 degree viewing angle, 35' x 30’ major motion and 20’ x 20’ minor motion range (PIR), 20' x 20’ major motion and 15’ x 15’ minor motion range (Ultrasonic); and positive detector indication.

2. Capable of switching all types of fluorescent ballasts, both solid-state electronic and magnetic ballasts, and incandescent lighting loads.

3. Dual element detection with time-out delay adjustable from 5 seconds to 20 minutes.

4. Shall be provided with neutral terminal as required by NEC.

5. Shall be rated for minimum 800 Watts at 120 VAC or 1200 Watts at 277 VAC.

6. Shall factory default to manual on operation and be equipped with manual off override, UL listed.

7. White protruding less than 1" from wall plate, mounts in single gang outlet box and utilizes decorator style rectangular opening wall plate, white nylon to match wiring devices, unless otherwise scheduled on Drawing E-503.

8. Basis of Design Manufacturer:

a. Legrand Wattstopper DW-100 and DSW-301 series, as scheduled on Drawing E-503

C. Dual Technology Wall Mounted Dimmable Sensors

1. Similar to above paragraph (B), except capable of dimming (0-10V) lighting loads.

2. Basis of Design Manufacturer:

a. Legrand Wattstopper DW-311

D. Low Voltage Momentary Switch

1. Single button, wall switch with momentary contact intended for use with compatible low voltage relay panels or power packs

2. LED indicator light

3. 24VDC, 50mA

4. Basis of Design Manufacturer:

   a. Legrand Wattstopper LVSW-100 series (1 button 101, 2 button 102..)

E. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.

2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.

3. Input Supply Voltage: Dual rated for 120/277 V ac.

4. Load Rating: As required to control the load indicated on the drawings.

5. Basis of Design Manufacturer: WattStopper BZ-150.

F. Dual Technology Ceiling Mounted Sensors (Low Voltage): 360-degree passive infrared and ultrasonic sensors for use with power packs, with adjustable time delay and sensitivity; coverage pattern suitable for the space. Basis of Design Manufacturer: WattStopper DT-300 and DT-305, as scheduled on Drawing E-503.

2.3 INTERIOR LIGHTING CONTROL DEVICES - DIGITAL

A. DLM Local Network (Room Network)

1. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.

2. Features of the DLM local network include:

   a. Plug n' G automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.

   b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.

   c. Push n' Learn™ configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.

d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

3. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.

4. If manufacturer's pre-terminated Cat5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.

5. Basis of Design Manufacturer

a. WattStopper Product Number: LMRJ-Series

B. Digital Load Controllers (Lighting Load & Plug Load)

1. Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications. The control units will include the following features:

a. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

b. Simple replacement - Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf.

c. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.

d. Device Status LEDs to indicate:

1) Data transmission

2) Device has power

3) Status for each load

4) Configuration status

e. Quick installation features including:

1) Standard junction box mounting

2) Quick low voltage connections using standard RJ-45 patch cable

f. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:

1) Turn on to 100%

2) Turn off

3) Turn on to last level

g. Each load shall at a minimum be configurable to operate in the following sequences based on occupancy:

1) Auto-on/Auto-off (Follow on and off)

2) Manual-on/Auto-off (Follow off only)

h. The polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.

i. BACnet object information shall be available for the following objects:

1) Load status

2) Electrical current (when available)

3) Total watts per controller

4) Schedule state - normal or after-hours

5) Demand response enable and disable

6) Room occupancy status

7) Total room lighting and plug loads watts

8) Total room watts/sq ft

9) Force on/off all loads

j. UL 2043 plenum rated

k. Manual override and LED indication for each load

l. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.

m. Zero cross circuitry for each load

n. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

2. On/Off/Dimming enhanced Room Controllers shall include:

a. Real time current monitoring

b. Multiple relay configurations

1) One, two or three relays (LMRC-21x series)

c. Efficient 250 mA switching power supply

d. Four RJ-45 DLM local network ports with integral strain relief and dust cover

e. One dimming output per relay

1) 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)

2) Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.

3) The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.

4) Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.

5) Calibration and trim levels must be set per output channel.

6) Devices that set calibration or trim levels per controller are not acceptable.

7) All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

f. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.

g. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.

h. The following dimming attributes may be changed or selected using a wireless configuration tool:

1) Establish preset level for each load from 0-100%

2) Set high and low trim for each load

3) Set lamp burn in time for each load up to 100 hours

i. Override button for each load provides the following functions:

1) Press and release for on/off control

2) Press and hold for dimming control

j. Acceptable Manufacturer's

1) WattStopper product numbers: LMRC-211, LMRC-212, LMRC-213, and LMRC-222 (exterior lighting zones, Drawing E-605)

C. Digital Plug Load Controllers: DLM plug load controller for automatic control of receptacles indicated as controlled, following room occupancy, UL 2043 plenum rated. Basis of Design Manufacturer: WattStopper LMPL-101.

D. Low Voltage Dual Relay Interface (DRI): DLM device with two isolated Class 2 dry-contact outputs for interface to the building automation system (BAS) occupancy inputs.

1. Provide one LMOR-102 at each and every room controller, connected to the room DLM local network and programmed to follow room occupancy.

2. Cabling between each LMOR-102 and the BAS controller is provided by the Contractor (single-prime contract). Coordinate termination points with the Division 23 controls contractor.

3. Basis of Design Manufacturer: WattStopper LMOR-102.

E. Digital Wall or Ceiling Mounted Occupancy/Vacancy Sensors

1. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.

2. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

    a. Digital calibration and pushbutton configuration for the following variables:

        1) Sensitivity - 0-100% in 10% increments

        2) Time delay - 1-30 minutes in 1 minute increments

        3) Test mode - Five second time delay

        4) Detection technology - PIR, Ultrasonic or Dual Technology activation and/or re-activation.

        5) Walk-through mode

    b. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

    c. Programmable control functionality including:

        1) Each sensor may be programmed to control specific loads within a local network.

        2) Sensor shall be capable of activating one of 16 user-definable lighting scenes.

        3) Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.

        4) On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:

        5) Ultrasonic and Passive Infrared

        6) Ultrasonic or Passive Infrared

        7) Ultrasonic only

        8) Passive Infrared only

        9) Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

    d. One or two RJ-45 port(s) for connection to DLM local network.

e. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

f. Device Status LEDs, which may be disabled for selected applications, including:

1) PIR detection

2) Ultrasonic detection

3) Configuration mode

4) Load binding

g. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.

h. Manual override of controlled loads.

i. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

F. Digital Wall Switches

1. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:

a. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.

b. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

c. Configuration LED on each switch that blinks to indicate data transmission.

d. Load/Scene Status LED on each switch button with the following characteristics:

1) Bi-level LED

2) Dim locator level indicates power to switch

3) Bright status level indicates that load or scene is active

4) Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

e. Programmable control functionality including:

1) Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority

2) Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

f. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

2. Two RJ-45 ports for connection to DLM local network.

3. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

4. The following switch attributes may be changed or selected using a wireless configuration tool:

5. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).

a. Individual button function may be configured to Toggle, On only or Off only.

b. Individual scenes may be locked to prevent unauthorized change.

c. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.

d. Ramp rate may be adjusted for each dimmer switch.

e. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.

6. Basis of Design Manufacturer

a. WattStopper product numbers: LMSW and LMDM series as scheduled on Drawing E-503 (including LMSW-210, LMDM-101, LMDM-102 and LMDM-103), compatible with wall plates with decorator opening.

G. Graphic Touchscreen: Wall-mounted DLM color graphic touchscreen for scene and zone control where scheduled; white. Basis of Design Manufacturer: WattStopper LMGS-150, as scheduled on Drawing E-503.

H. Digital Daylighting Sensors

1. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.

    a. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.

2. Digital daylighting sensors shall include the following features:

    a. The sensor’s internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode’s spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrum's. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.

    b. Sensor light level range shall be from 1-6,553 footcandles (fc).

    c. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).

    d. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling excessively after they turn off.

    e. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.

    f. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.

    g. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.

    h. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.

    i. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.

    j. Configuration LED status light on device that blinks to indicate data transmission.

k. Status LED indicates test mode, override mode and load binding.

l. Recessed switch on device to turn controlled load(s) ON and OFF.

m. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:

1) Light level

2) Day and night setpoints

3) Off time delay

4) On and off setpoints

5) Up to three zone setpoints

6) Operating mode - on/off, bi-level, tri-level or dimming

n. One RJ-45 port for connection to DLM local network.

o. A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62" thickness (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62"-1.25" thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.

p. Any load or group of loads in the room can be assigned to a daylighting zone

q. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).

r. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

3. Open loop digital photosensors shall include the following additional features:

a. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).

b. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone

shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

c. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.

d. Basis of Design WattStopper Product Number: LMLS-500, LMLS-500-L.

I. Handheld and Computer Configuration Tools

1. A wireless configuration tool facilitates optional customization of DLM local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.

2. Features and functionality of the wireless configuration tool shall include but not be limited to:

a. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.

b. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.

c. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.

d. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.

e. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.

f. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.

g. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.

h. Verify status of building level network devices.

3. Provide 1 unit, turn over to owner during commissioning, for use with this project.

4. Basis of Design Manufacturer: WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.4 NETWORK BRIDGE, SCHEDULING AND SOFTWARE

A. Network Bridge: DLM network bridge connecting each room DLM local network to the BACnet MS/TP building network for scheduling and BAS integration, with BACnet objects for each room including occupancy, load status and normal-hours/after-hours control. Basis of Design Manufacturer: WattStopper LMBC-300; quantity and locations as indicated.

B. Astronomical Time Clock: Seven-day astronomical time clock for time-of-day and exterior lighting control where indicated, with holiday schedules, automatic daylight saving time adjustment and program retention during power loss. Basis of Design Manufacturer: WattStopper RT-200, as scheduled on Drawing E-503.

C. BAS Integration: Coordinate BACnet device instances, network numbers and point lists with the Division 23 controls contractor and the Campus.

D. Programming, Configuration and Documentation Software

1. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.

2. Additional parameters exposed through this method include but are not limited to:

a. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.

b. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.

c. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.

d. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.

e. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.

f. Load control polarity reversal so that on events turn loads off and vice versa.

g. Per-load DR (demand response) shed level in units of percent.

h. Load output pulse mode in increments of 1second.

i. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.

3. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:

a. Device list report: All devices in a project listed by type.

b. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.

c. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.

d. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.

e. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.

f. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).

g. Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors.

4. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:

a. Set, copy/paste an entire project site of sensor time delays.

b. Set, copy/paste an entire project site of sensor sensitivity settings.

c. Search based on room name and text labels.

d. Filter by product type (i.e. LMRC-212) to allow parameter set by product.

e. Filter by parameter value to search for product with specific configurations.

5. Network-wide firmware upgrading remotely via the BACnet/IP network.

a. Mass firmware update of entire rooms.

b. Mass firmware update of specifically selected rooms or areas.

c. Mass firmware upgrade of specific products.

6. Basis of Design Manufacturer

a. WattStopper Product Number: LMCS-100, LMCI-100

2.5 EMERGENCY BYPASS/SHUNT RELAY

A. A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz, 20 amp ballast rating

2. Push to test button

3. Auxiliary contact for remote test or fire alarm system interface

a. Acceptable Manufacturer’s

b. WattStopper Product Numbers: ELCU-100, ELCU-200

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which control equipment is to be installed and notify Architect in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CONTROL EQUIPMENT

A. Install control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.

B. Coordinate with other electrical Work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment Work.

C. LMOR-102 Relay Interfaces: Provide and terminate cabling from each LMOR-102 to the BAS controller input designated by the Division 23 controls contractor. Label each cable with the room number at both ends.

3.3 INSTALLATION OF OCCUPANCY/VACANCY SENSORS

A. All units shall be secured to an outlet box and per manufacturer's written installation instructions; Drawings are for informational purposes only. Manufacturer shall have field-trained rep available to assist Contractor during installation.

B. All necessary wiring diagrams shall be furnished to Contractor by manufacturer for installation.

C. All sensors shall be adjusted in field to pick up door swing within range of viewer; Contractor shall adjust or move device as required.

D. Provide all necessary control units, relays, wallplates, mounting brackets, filters, sensor covers, backboxes and other equipment necessary to make completely operational system. All equipment but sensor shall be recess mounted, concealed.

E. All control units shall be wired such that wall switches (if present) can switch room lamps off. Program occupancy sensor control (manual-on or auto-on operation, time delays and dimming levels) as shown in the Lighting Design Matrix on Drawing E-503, in compliance with the ECCCNYS.

F. Provide all required additional sensors for complete room coverage as required by system.

G. Wall sensors shall be mounted at same height as switches.

H. Provide complete written checkout signed by manufacturer's representative, Contractor and Owner's Site Representative after complete installation of system.

1. All occupancy sensor wiring, including both power and control wiring, shall be installed in raceway systems as specified.

2. Wire vacancy sensors so that lighting shuts off at or less than 15 minutes after the occupant leaves the room. It will be necessary for the occupant to manually turn the lights back on.

3. Wire the occupancy sensors that control the split-wire controlled receptacles so that the top portion of each controlled duplex receptacle shuts off less than 20 minutes after the occupant leaves the room. It is not necessary for the occupant to manually turn the receptacles back on; they shall automatically energize upon returning to the room.

3.4 INSTALLATION OF EMERGENCY BYPASS/SHUNT RELAY

A. Install in accordance with manufacturer’s printed instructions as a shunt or bypass device, unless otherwise noted.

B. Install relay device concealed above accessible ceiling, mounted to outlet box. Install test switch on wall 12” below ceiling, flush mounted.

C. Test each unit to ensure proper operation.

3.5 PERSONNEL TRAINING

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

B. Provide two 1 hour sessions to train facility personnel on the use, operation and maintenance of the system.

3.6 FACTORY COMMISSIONING & STARTUP

A. Upon completion of the installation, the system shall be fully commissioned by the manufacturer's factory authorized representative who will verify, program/set and witness test the fully functional system

1. Confirm occupancy sensors acceptable performance of placement, sensitivity and settings.

2. Confirm time switches and schedule controls are correctly programmed, functioning and documented.

3. Confirm daylighting responsive controls are properly located, calibrated, accessible and function to adjust lighting in response to available daylight.

4. Submit documentation certifying performance.

END OF SECTION 26 09 23

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SECTION 26 12 16.11 - DRY-TYPE, CAST-COIL, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Medium-voltage, dry-type, cast-coil, substation transformers.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 13 - Medium-Voltage Cables: Primary cables and terminations.

C. Section 26 24 13 - Switchboards: Close-coupled main switchboard MSB.

1.3 DEFINITIONS

A. Transformers may also be identified as MV XFMR or XFMR.

1.4 REFERENCE STANDARDS

A. 10 CFR 429 - Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment; Current Edition.

B. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

C. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

D. IEEE C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers; 2021.

E. IEEE C57.12.01 - IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers; 2020.

F. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers; 2020.

G. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

H. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015.

I. NEMA TR 1 - Transformers, Step Voltage Regulators and Reactors; 2013 (Reapproved 2019).

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

L. UL 1562 - Standard for Transformers, Distribution, Dry-Type – Over 600 Volts; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.

B. Scheduling: Do not schedule functional demonstration testing until operational readiness testing is complete and associated report and certification have been submitted.

1.6 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.

C. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets for transformers, enclosures, components, and accessories.

E. Shop Drawings: Indicate enclosure dimensions, kVA, primary and secondary nominal voltage, voltage taps, required clearances, and unit weight.

F. Functional Demonstration Testing Report: Document test results, including assumptions, conditions, allowances, and corrections made.

G. Operation and Maintenance Data:

1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

H. Executed warranty.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.

2. Requirements of local authorities having jurisdiction.

3. Applicable local codes.

B. Manufacturer Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.

2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.

3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.

4. Certified in accordance with ISO 14001.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.

C. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Division 01 closeout requirements for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 12 months from date of commissioning or 18 months from date of shipment, whichever comes first. Complete forms in SUNY's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric; Square D Power-Cast II and Uni-Cast II Transformers; www.se.com/#sle.

B. MGM.

C. Hammond.

D. Source Limitations: Furnish products produced by manufacturer of other electrical distribution equipment for project and obtained from single supplier.

2.2 MEDIUM-VOLTAGE, DRY-TYPE, CAST-COIL, SUBSTATION TRANSFORMERS

A. Basis of Design: Schneider Electric; Square D Power-Cast II and Uni-Cast II Transformers; www.se.com/#sle.

B. Transformer Ratings/Configurations: As indicated on drawings.

C. Comply with NEMA TR 1 and IEEE C57.12.01; list and label as complying with UL 1562.

D. Efficiency: Comply with 10 CFR 431, Subpart K; registered on Department of Energy's Compliance Certification Database in accordance with 10 CFR 429.

E. Cooling Type: Ambient air/forced air (AA/FA).

1. Forced-Air-Cooling: Increase allowable full-load kVA by 33.3 percent.

F. Primary Taps: Two 2.5 percent full capacity above normal, two 2.5 percent full capacity below normal.

G. Impedance: 5.75 percent, plus/minus 7.5 percent.

H. Sound Levels: Not to exceed values specified in IEEE C57.12.01.

I. Fan Cooling Equipment:

1. Include 3-phase electronic winding temperature monitor controlled automatically by sensors placed in low-voltage air duct.

2. Provide yellow indicating light for fan power and red indicating light for alarm and trip contact activation.

3. Provide 0-1 mA output for remote indication.

4. Provide alarm contacts for fans, alarm, and trip function.

5. Provide audible alarm that sounds when highest phase temperature exceeds preset point.

6. Provide fans capable of operating in manual or automatic mode.

7. Provide fan exerciser circuit to operate cooling fans for approximately one minute every six days.

8. Wire the fan-failure, high-temperature alarm and trip contacts to the building management system (BMS) through the nearest BMS panel; coordinate points with the Division 23 controls contractor.

9. Provide Model 98A fan controller compatible with PowerLogic system.

10. Forced Air Cooling System: Provide fans, control wiring, controller with test switch, current limiting fusing in power supply to controller, indicating lights, alarm silencing relay, auto/manual switch, and necessary accessories to properly control system.

11. Fan Power Source: Internal control power transformer.

J. Transformer Cores:

1. Construct of high-grade, grain-oriented, nonaging silicon steel with high magnetic permeability.

2. Magnetic Flux Densities: Maintain well below saturation point.

3. Core Shape: Cruciform, with mitered joints to keep core losses, excitation current, and noise level at minimum.

4. Protect outside surfaces of core against corrosion by painting with suitable coating after assembly.

K. Transformer Coils:

1. General Requirements:

a. Winding Material: Copper.

b. Provide coil supports that maintain constant pressure during thermal expansion and contraction of coils; make no rigid mechanical connection between high- and low-voltage coils.

c. Windings not to absorb moisture; suitable for storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperatures from minus 22 degrees F to 104 degrees F; capable of immediately being switched on after storage without predrying.

2. Epoxy-Cast High- and Low-Voltage Windings:

a. Separately cast high- and low-voltage windings as one rigid tubular coil, arrange coaxially.

b. Reinforce cast coils with glass mat.

c. Provide complete, void-free resin impregnation throughout entire insulation system.

d. Temperature Rise: Average 80 degrees C above maximum 40-degree C, average 30-degree C ambient.

e. Basic Impulse Levels (BIL):

1) High-Voltage Windings: Equivalent to IEEE C57.12.00 requirements for liquid-filled transformers of same voltage class without use of supplemental surge arresters.

2) Low-Voltage Windings:

(a) 30 kV for 1.2 kV class.

(b) 45 kV for 2.5 kV class.

(c) 60 kV for 5 kV class.

L. Low-Voltage Bussing Material:

1. Units with Aluminum Windings: Tin-plated aluminum throughout.

2. Units with Copper Windings: Silver-flash-plated copper throughout.

M. Enclosures:

1. Construction: Steel, ventilated.

2. Environment Type: Indoor.

3. Finish: Painted, ANSI 49 gray.

4. Construct base to permit skidding or rolling in any direction; equip with jacking pads flush with transformer enclosure.

5. Provide cabinet with minimum of four hinged doors complete with door handles.

N. Primary Termination Compartment: Air-filled, sized for three 15 kV shielded cables with terminations per Section 26 05 13; top or bottom entry as required.

O. Secondary Connection: Close-coupled throat to main switchboard MSB (Section 26 24 13) with flexible bus connectors; coordinate throat location, dimensions and phasing with the switchboard manufacturer. Secondary: 480Y/277 V; bond the neutral (XO) at the transformer. The neutral is not extended to switchboard MSB.

P. Markings and Labeling:

1. Provide identification and warning labels/nameplates exterior to equipment resistant to weather, UV, and intended installation environment.

2. Provide engraved nameplates identifying project-specific equipment tag and service description.

3. Provide warning labels/nameplates complying with ANSI Z535.4 at access locations to advise personnel of possible hazards in accordance with listing, NFPA 70, NFPA 70E, and other applicable standards.

2.3 SOURCE QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Testing:

1. Test transformers accordance with IEEE C57.12.91 including:

a. Ratio.

b. Polarity.

c. Phase rotation.

d. No-load loss.

e. Excitation current.

f. Impedance voltage.

g. Load loss.

h. Applied potential.

i. Induced potential.

j. QC impulse test.

k. Temperature test. Typical test data from previous testing may be used.

l. Sound test. Typical test data from previous testing may be used.

m. Partial discharge testing; transformer windings to be free of partial discharge up to minimum of 1.2 times rated line-to-ground voltage.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.

B. Examine for conditions detrimental to completion of work.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer’s written instructions.

B. Unless otherwise indicated, install and anchor transformers on raised concrete pad 4 inches high; see Section 03 30 00.

3.3 FIELD QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.

1. Include necessary material, equipment, labor, and technical supervision.

2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.

3. Identify transformers with label indicating inspection/testing agency and date of service.

C. Operational Readiness Testing:

1. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer’s recommendations, and readiness for operation.

a. Visually inspect for physical damage and proper installation.

b. Perform tests in accordance with manufacturer's instructions.

c. Perform tests to verify compliance with Contract Documents.

d. Perform tests to verify equipment is ready for operation.

e. Touch-up paint chips and scratches with manufacturer-supplied paint.

3.4 CLOSEOUT ACTIVITIES

A. See Division 01 closeout requirements for additional submittals.

B. Functional Demonstration Testing: Demonstrate proper operation of transformers and associated systems to SUNY's designated representative and Engineer, observing and documenting compliance with Contract Documents.

C. Training:

1. Train SUNY's personnel on operation and maintenance of system.
    a. Accommodate minimum of four attendees.
    b. Provide not less than one session(s) with two hours of classroom and hands-on training.
    c. Training Reference: Use submitted operations and maintenance manuals.
    d. Instructor: Factory-trained manufacturer's representative.
    e. Location: Project site.
2. Provide sufficient time and detail in each session to cover the following at minimum:
    a. Operation theory.
    b. Major equipment components.
    c. Equipment operation.
    d. Equipment configurations.
    e. Maintenance, troubleshooting, and repair.
    f. Component-level parts replacement.

3.5 PROTECTION

A. Protect installed transformers from subsequent construction operations.

END OF SECTION

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SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General purpose transformers.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 25 00 - Enclosed Bus Assemblies: Busway connection to transformer T-MDPL.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 33.13 - Conduit for Electrical Systems: Flexible conduit connections.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 24 16 - Panelboards.

1.3 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.

C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.

G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with placement of supports, anchors, etc. required for mounting.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

B. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.

1. Greater than 10 kVA: 104 degrees F maximum.

2. Less than 10 kVA: 77 degrees F maximum.

1.9 WARRANTY

A. See Division 01 closeout requirements, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE

B. Eaton Corporation

C. Schneider Electric; Square D Products

D. Siemens Industry, Inc

E. Source Limitations: Provide transformers produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet.

2. Ambient Temperature:

a. Greater than 10 kVA: Not exceeding 104 degrees F.

b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:

1. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:

1. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

2. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

H. Sound Levels: Standard sound levels complying with NEMA ST 20

I. Mounting Provisions:

1. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor clean, dry locations: Type 2.

2. Construction: Steel.

a. 15 kVA and Larger: Ventilated.

3. Finish: Manufacturer's standard grey, suitable for outdoor installations.

4. Provide lifting eyes or brackets.

K. Accessories:

1. Mounting Brackets: Provide manufacturer's standard brackets.

2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.4 PROJECT-SPECIFIC TRANSFORMER REQUIREMENTS

A. Fire Pump Transformer T-FP: 225 kVA, 480 V delta primary, 208Y/120 V secondary, copper windings, 150 degrees C rise, ventilated. Impedance: standard catalog impedance, not more than 6.0 percent, so the voltage drop at the fire pump controller during motor starting complies with NFPA 70, 695.7 (see Section 26 05 73). Submit the nameplate impedance with the product data. Dedicated to the fire pump and its accessories; no other loads.

B. Distribution Transformer T-MDPL: 750 kVA, 480 V delta primary, 208Y/120 V secondary, copper windings, 150 degrees C rise, ventilated. Provide a flanged secondary throat for connection of the 2500 A busway to switchboard MDPL (Section 26 25 00); coordinate throat location, bus phasing and dimensions with the busway and switchboard manufacturers.

2.5 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:

1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.

2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.

3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.

4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

I. Mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with manufacturer's recommendations.

J. Provide grounding and bonding in accordance with Section 26 05 26.

K. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

L. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

M. Identify transformers in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

1. All transformers:

a. Perform turns ratio tests at all tap positions.

3.4 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

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SECTION 26 24 13 - SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 12 16.11 - Dry-Type, Cast-Coil, Medium-Voltage Transformers: Unit substation transformer close-coupled to switchboard MSB.

D. Section 26 25 00 - Enclosed Bus Assemblies: Busway from transformer T-MDPL to switchboard MDPL.

E. Section 26 28 16.16 - Enclosed Switches and Circuit Breakers: Fire pump disconnecting means.

F. Section 26 05 29 - Hangers and Supports for Electrical Systems.

G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 43 00 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

F. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less; 2023.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

K. UL 891 - Switchboards; Current Edition, Including All Revisions.

L. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.

5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Division 01, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings upon request.
5. Include documentation demonstrating selective coordination upon request.

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, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Switchboards:

1. ABB: www.electrification.us.abb.com/#sle.

2. Eaton Corporation: www.eaton.com/#sle.

3. Schneider Electric: www.se.com/#sle.

4. Siemens Industry, Inc: www.new.siemens.com/#sle.

2.2 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:

1. Main Device(s): Individually-mounted.

2. Feeder Devices: Panel/group-mounted.

3. Arrangement: Front accessible only (not rear accessible), rear aligned.

4. Gutter Access: Bolted covers.

E. Switchboards With Fire Pump Taps: Provide separate bussed vertical section with suitable lugs for fire pump connection to line side of main service disconnect device(s). The fire pump disconnecting means is a separate wall-mounted enclosed circuit breaker; see Section 26 28 16.16.

F. Service Conditions:

1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:

    a. Altitude: Less than 6,600 feet.

    b. Ambient Temperature:

        1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.

2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

G. Short Circuit Current Rating:

1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed. Switchboard MSB: close-coupled to the unit substation transformer secondary throat (Section 26 12 16.11). Switchboard MDPL: main section with flanged busway entrance for the 2500 A busway from transformer T-MDPL (Section 26 25 00).

I. MSB Main Circuit Breaker: 2500 A frame, 2500 A trip, electronic trip unit with long-time, short-time, instantaneous and ground-fault (LSIG) functions, 100 percent rated (listed for continuous operation at 100 percent of its rating in the switchboard enclosure). Insulated-case or power circuit breaker construction as required for the 100 percent rating.

J. Bussing: Sized in accordance with UL 891 temperature rise requirements.

1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.

2. Provide fully rated neutral bus unless otherwise indicated (switchboard MSB is 480 V, 3-phase, 3-wire with no neutral bus; the neutral is bonded at the unit substation transformer and not distributed), with a suitable lug for each feeder or branch circuit requiring a neutral connection.

3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

4. Phase and Neutral Bus Material: Copper.

5. Ground Bus Material: Copper.

K. Conductor Terminations: Suitable for use with the conductors to be installed.

1. Line Conductor Terminations:

a. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors.

b. Main and Neutral Lug Type: Mechanical.

2. Load Conductor Terminations:

a. Lug Material: Copper, suitable for terminating copper conductors.

b. Lug Type:

1) Provide mechanical lugs unless otherwise indicated.

L. Enclosures:

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).

b. Outdoor Locations: Type 3R.

2. Finish: Manufacturer's standard unless otherwise indicated.

3. Outdoor Enclosures:

a. Color: Manufacturer's standard.

b. Access Doors: Lockable, with all locks keyed alike.

M. Future Provisions:

1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.

3. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.

N. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.

O. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.

a. Use residual ground fault detection method unless otherwise indicated.

b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

P. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

Q. SUNY Metering:

1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.

2. Measured Parameters:

a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.

b. Current (Amps): For each phase and neutral.

c. Frequency (Hz).

d. Real power (kW): For each phase, 3-phase total.

e. Reactive power (kVAR): For each phase, 3-phase total.

f. Apparent power (kVA): For each phase, 3-phase total.

g. Power factor.

h. Real energy (kWh).

i. Reactive energy (kVARh).

j. Apparent energy (kVAh).

k. Current demand.

l. Power demand: Real, reactive, and apparent.

3. Meter Accuracy: Plus/minus 1.0 percent.

4. Features:

    a. KYZ pulse output.

    b. BACnet communication (BACnet/IP or BACnet MS/TP, as required by the Campus BMS).

5. Provide meters in switchboards MSB and MDPL.

6. Provide communication cabling from each meter to the nearest BMS panel, and coordinate integration with the Division 23 controls contractor.

R. Instrument Transformers:

1. Comply with IEEE C57.13.

2. Select suitable ratio, burden, and accuracy as required for connected devices.

3. Current Transformers: Connect secondaries to shorting terminal blocks.

4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:

1. Interrupting Capacity:

    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.

    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

2. Molded Case Circuit Breakers:

    a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

        1) Provide thermal magnetic circuit breakers unless otherwise indicated.

        2) Provide electronic trip circuit breakers where indicated.

    b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

2) Provide interchangeable trip units where indicated.

c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

1) Provide the following field-adjustable trip response settings:

(a) Long time pickup, adjustable by setting dial.

(b) Long time delay.

(c) Short time pickup and delay.

(d) Instantaneous pickup.

(e) Ground fault pickup and delay where ground fault protection is indicated.

d. Provide the following circuit breaker types where indicated:

1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.

e. Provide the following features and accessories where indicated or where required to complete installation:

1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

3) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.4 SOURCE QUALITY CONTROL

A. See Division 01 quality requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:

1. Dielectric tests.

2. Mechanical operation tests.

3. Grounding of instrument transformer cases test.

4. Electrical operation and control wiring tests, including polarity and sequence tests.

5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Install all field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.

L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

M. Provide filler plates to cover unused spaces in switchboards.

N. Identify switchboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Division 01 quality requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 400 amperes. Tests listed as optional are not required.

H. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

I. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

J. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

K. Test shunt trips to verify proper operation.

L. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. Training: Train SUNY's personnel on operation, adjustment, and maintenance of switchboard and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.7 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.

E. Section 26 43 00 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

E. NEMA PB 1 - Panelboards; 2011.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 67 - Panelboards; Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

M. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

C. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

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 carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE

B. Eaton Corporation

C. Schneider Electric; Square D Products

D. Siemens Industry, Inc

E. Source Limitations: Provide panelboards and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.

2. Ambient Temperature:

a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating as indicated on the drawings.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.

2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.

b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

c. Provide removable end walls for NEMA Type 1 enclosures.

3. Fronts:

a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.

K. Load centers are not acceptable.

L. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.

2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase and Neutral Bus Material: Copper.

2. Ground Bus Material: Copper.

D. Circuit Breakers:

1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

2. Provide thermal magnetic circuit breakers unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted enclosures unless otherwise indicated.

2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Copper.

3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:

a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

1) 10,000 A rms symmetrical for 208Y/120 V panelboards.

2) 14,000 A rms symmetrical for 480 V panelboards.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Conductor Terminations:

a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

b. Provide interchangeable trip units where indicated.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

a. Provide the following field-adjustable trip response settings:

1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

2) Long time delay.

3) Short time pickup and delay.

4) Instantaneous pickup.

5) Ground fault pickup and delay where ground fault protection is indicated.

6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

7. Provide the following circuit breaker types where indicated:

   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

   c. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

   d. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

   e. Shunt Trip Circuit Breakers: Coil voltage as required for the actuating circuit. Provide for electric cooking equipment under the kitchen exhaust hoods, interlocked with the hood fire suppression system, and elsewhere as indicated.

   f. HACR-Rated Circuit Breakers: Listed for heating, air-conditioning and refrigeration equipment where the equipment nameplate requires HACR-type protection.

8. Do not use handle ties in lieu of multi-pole circuit breakers.

9. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.6 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

J. Provide grounding and bonding in accordance with Section 26 05 26.

1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.

K. Install all field-installed branch devices, components, and accessories.

L. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Provide filler plates to cover unused spaces in panelboards.

O. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:

1. Emergency and night lighting circuits.

2. Fire detection and alarm circuits.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Provide follow--up thermographic survey.

C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 400 amperes. Tests listed as optional are not required.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

E. Test GFCI circuit breakers to verify proper operation.

F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 25 00 - ENCLOSED BUS ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Feeder busway (enclosed bus assembly) and fittings from distribution transformer T-MDPL to switchboard MDPL.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems.

D. Section 26 05 73 - Power System Studies.

E. Section 26 22 00 - Low-Voltage Transformers: Transformer T-MDPL busway throat.

F. Section 26 24 13 - Switchboards: Switchboard MDPL busway entrance.

1.3 REFERENCE STANDARDS

A. NECA 408 - Standard for Installing and Maintaining Busways; Current Edition.

B. NEMA BU 1.1 - General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less; Current Edition.

C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 857 - Busways; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate flanged ends, bus phasing and dimensions with the manufacturers of transformer T-MDPL and switchboard MDPL.

B. Field-verify the route, elevations and lengths in Electrical Room 194A before fabrication. Coordinate with structure, ductwork and piping, and keep the busway out of the dedicated electrical space above other equipment except where it serves that equipment.

1.5 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Product Data: Busway construction, ratings, fittings and accessories.

C. Shop Drawings: Dimensioned plan and elevation layout with fittings, flange details, joint and hanger locations, and clearances.

D. Impedance Data: For use in the power system studies (Section 26 05 73).

E. Field Test Reports.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store indoors in a clean, dry space; protect from moisture and construction debris. Handle in accordance with NEMA BU 1.1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Same manufacturer as switchboard MDPL: ABB; Eaton Corporation; Schneider Electric (Square D); Siemens Industry, Inc.

2.2 FEEDER BUSWAY

A. Description: Totally enclosed, non-ventilated, sandwich-type feeder busway listed and labeled as complying with UL 857; for indoor use.

B. Rating: 2500 A continuous, 600 V class, 3-phase, 4-wire with 100 percent rated neutral, applied at 208Y/120 V.

C. Short Circuit Current Rating: Not less than the available fault current determined by the study in Section 26 05 73, and not less than the rating of switchboard MDPL.

D. Bus Bars: Copper, fully insulated, with plated contact surfaces at joints.

E. Ground: Integral copper ground bus, 50 percent rated minimum; the housing is not the only ground path.

F. Joints: Single-bolt type with torque-indicating bolts, accessible from either side.

G. Fittings: Elbows, offsets, flanged ends for the transformer and switchboard, expansion fittings where required, and end closures.

H. Hangers: Manufacturer's standard, at the spacing the manufacturer recommends. Seismic restraints are not required.

I. Finish: Manufacturer's standard gray.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that the transformer and switchboard are set and that the route is clear before installation.

3.2 INSTALLATION

A. Install busway in accordance with NECA 408, NEMA BU 1.1 and the manufacturer's instructions.

B. Support from building structure; do not support from ductwork, piping or ceiling systems. See Section 26 05 29.

C. Tighten joints to the manufacturer's torque values.

D. Provide grounding and bonding in accordance with Section 26 05 26.

E. Identify busway in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, Section 7.4 (busways), except Section 4.

B. Perform insulation resistance tests before energizing.

C. After the system is under load, perform an infrared thermographic survey of joints and terminations; correct deficiencies.

3.4 PROTECTION

A. Protect installed busway from construction damage, moisture and debris until energized.

END OF SECTION

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SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates and covers.

D. Floor box service fittings.

E. Poke-through assemblies.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).

F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 WIRING DEVICES - GENERAL REQUIREMENTS

A. Provide wiring devices suitable for intended use with ratings adequate for load served.

B. Wiring Device Applications:

1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.

2. Provide GFCI protection for:

a. Receptacles installed within 6 feet of sinks.

b. Receptacles installed in kitchens.

c. Receptacles serving electric drinking fountains.

3. Single Receptacles Installed on Individual Branch Circuits: Provide receptacle ampere rating equal to branch circuit rating.

C. Wiring Device Finishes:

1. Provide wiring device finishes as described below, unless otherwise indicated.

2. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.

3. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.

4. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.

5. Wiring Devices Installed in Wet or Damp Locations: White with weatherproof cover.

6. Flush Poke-Through Service Fittings: Gray wiring devices with aluminum cover and aluminum flange.

7. Access Floor Boxes: Gray wiring devices with gray steel cover with insert to match floor covering.

2.2 MANUFACTURERS

A. Hubbell Incorporated

B. Leviton Manufacturing Company, Inc

C. Lutron Electronics Company, Inc

D. Pass & Seymour, a brand of Legrand North America, Inc

2.3 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI protection for receptacles installed within 6 feet of sinks.

E. Provide GFCI protection for receptacles installed in kitchens.

F. Provide GFCI protection for receptacles serving electric drinking fountains.

2.4 WALL SWITCHES

A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

B. Standard Wall Switches: Hard use specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.5 RECEPTACLES

A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.

2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:

1. Standard Convenience Receptacles: Hard use specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

2. Automatically Controlled Convenience Receptacles: Hard use specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.

3. Weather Resistant Convenience Receptacles: Hard use specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated.

4. Tamper Resistant Convenience Receptacles: Hard use specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.

5. Locking Receptacles: Hard use specification grade, 30 A, 250 V, 2-pole, 3-wire grounding, NEMA L6-30R; for data rack power where indicated.

C. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

2. Standard GFCI Receptacles: Hard use specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Weather Resistant GFCI Receptacles: Hard use specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.

D. USB Charging Devices:

1. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type C) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

2.6 WALL PLATES AND COVERS

A. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.

2. Size: Standard.

3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

C. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.7 FLOOR BOX SERVICE FITTINGS

A. Description: Service fittings compatible with floor boxes provided under Section 26 05 33.16 with components, adapters, and trims required for complete installation.

B. Types, configurations and basis of design: As scheduled in the floor box schedule on Drawing E-601.

2.8 POKE-THROUGH ASSEMBLIES

A. Manufacturers:

1. Hubbell Incorporated

2. Thomas & Betts Corporation

3. Wiremold, a brand of Legrand North America, Inc

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed. Provide in accordance with contract drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that core drilled holes for poke-through assemblies are in proper locations.

G. Verify that openings in access floor are in proper locations.

H. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:

a. Wall Switches: 48 inches above finished floor.

b. Receptacles: 18 inches above finished floor or 6 inches above counter.

2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.

5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

N. Identify wiring devices in accordance with Section 26 05 53.

O. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

A. Inspect each wiring device for damage and defects.

B. Operate each wall switch with circuit energized to verify proper operation.

C. Test each receptacle to verify operation and proper polarity.

D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fuses.

1.2 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

B. Section 26 28 16.16 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.

2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.

3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation

B. Littelfuse, Inc

C. Mersen

2.2 APPLICATIONS

A. General Purpose Branch Circuits: Class RK1, time-delay.

B. Individual Motor Branch Circuits: Class RK1, time-delay.

2.3 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

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SECTION 26 28 15 - CIRCUIT BREAKERS FOR EXISTING PANELBOARDS

PART 1 GENERAL

1.1 SUBMITTALS

A. Not required.

PART 2 PRODUCTS

2.1 CIRCUIT BREAKERS

A. Similar to existing circuit breakers.

B. Compatible with existing panelboard/switchboard.

C. Number of poles and ampere trip rating as indicated on drawings.

D. Complete with accessories required for installation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install new circuit breakers in existing panelboards where indicated.

B. Add new circuits equally across phases to prevent overloading any phase in the panelboard. After new and existing circuits are energized, take current reading on panelboard feeder during a heavy usage time period. If phases are substantially unbalanced, rearrange both new and existing circuits in panelboard to equally distribute load between all phases, and provide new typewritten directory indicating equipment controlled by each circuit breaker.

END OF SECTION

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SECTION 26 28 16.16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

B. Enclosed circuit breakers.

C. Fire pump disconnecting means.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 28 13 - Fuses.

E. Section 26 36 00 - Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

C. Project Record Documents: Record actual locations of enclosed switches.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE

B. Eaton Corporation

C. Schneider Electric; Square D Products

D. Siemens Industry, Inc

E. Source Limitations: Provide enclosed switches and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.2 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.

2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy Duty Switches:

1. Comply with NEMA BS 31047.

2. Conductor Terminations:

a. Provide mechanical lugs unless otherwise indicated.

b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

a. Provide means for locking handle in the ON position.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Description: Molded-case circuit breaker (insulated-case where the indicated frame requires) in an enclosure, listed and labeled as complying with UL 489; ratings, trip types and features as indicated for each enclosed circuit breaker (ECB designations on the drawings).

B. Interrupting Rating: Not less than the available fault current at the installed location as determined by the short circuit study (Section 26 05 73).

C. Trip Units: Thermal-magnetic unless otherwise indicated. Where LSI or LSIG is indicated, provide a true-rms electronic trip unit with adjustable long-time pickup and delay, short-time pickup and delay, instantaneous pickup, and (LSIG) ground-fault pickup and delay. Where the indicated frame size is not available with the indicated trip type, notify the Engineer before submittal.

D. Accessories, as indicated: Shunt trip with coil voltage as required by the actuating circuit; auxiliary contacts (minimum one normally open and one normally closed); alarm (bell) contact; padlock provision for locking OFF.

E. Enclosures: NEMA EN 10250 Type 1 for indoor clean, dry locations; Type 12 where indicated; Type 3R outdoors. Externally operable handle indicating ON, OFF and TRIPPED.

F. Elevator Disconnects (ECB-ELV1, ECB-ELV2): 480 V, 3-pole, with auxiliary contacts for the elevator controller; coordinate final ratings with the approved elevator submittal.

2.4 FIRE PUMP DISCONNECTING MEANS

A. Provide the fire pump disconnecting means on the primary of fire pump transformer T-FP as an enclosed circuit breaker complying with NFPA 70, 695.4(B), rated 600 A frame, 600 A trip at 480 V as indicated, wall-mounted and separate from the MSB lineup.

B. Rating: Capable of carrying the locked-rotor current of the fire pump motor and the fire pump accessory equipment indefinitely, as reflected through T-FP (NFPA 70, 695.4(B)(2) and 695.5(B)).

C. Trip Unit: Thermal-magnetic or electronic without ground-fault protection (NFPA 70, 695.6(G)); set the instantaneous above transformer inrush and the reflected locked-rotor current, per Section 26 05 73.

D. Lockable in the closed (ON) position, with an auxiliary contact for supervision of the open position by the fire alarm system (NFPA 70, 695.4(B)(3)).

E. Marking: "FIRE PUMP DISCONNECTING MEANS" in letters not less than 1 inch high, and a placard at the fire pump controller stating the location of the disconnecting means and of the key; see Section 26 05 53.

F. Enclosure: NEMA Type 1, with lugs and fittings suitable for the MI cable feeders indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Fire Pump Disconnecting Means: Wall-mount in Electrical Room 194A where indicated. Connect the supervisory contact to the fire alarm system (Section 28 46 00). Lock in the closed position after acceptance testing.

J. Identify enclosed switches in accordance with Section 26 05 53.

3.3 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 7.5.1.1.

C. Enclosed Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1. Set adjustable trip units per the coordination study (Section 26 05 73).

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

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SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:

1. Magnetic motor starters.
2. Manual motor starters.
3. Motor-starting switches without overload protection.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.3 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

E. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

F. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

J. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

K. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.

3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.

4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

6. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Field Quality Control Test Reports.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE

B. Eaton Corporation

C. Schneider Electric; Square D Products

D. Siemens Industry, Inc

2.2 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:

1. Provide controllers and associated components suitable for operation under the following service conditions without derating:

a. Altitude:

1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.

2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.

b. Ambient Temperature: Between 32 degrees F and 104 degrees F.

2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:

1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures:

1. Comply with NEMA IA 10030.

2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 12.

b. Outdoor Locations: Type 3R or Type 4.

3. Finish: Manufacturer's standard unless otherwise indicated.

H. Instrument Transformers:

1. Comply with IEEE C57.13.

2. Select suitable ratio, burden, and accuracy as required for connected devices.

3. Current Transformers: Connect secondaries to shorting terminal blocks.

4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

I. Magnetic Motor Starters: Combination type unless otherwise indicated.

1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).

2. Noncombination Magnetic Motor Starters: NEMA ICS 2, Class A noncombination motor controllers with magnetic contactor(s) and overload relay(s).

3. Configuration: Full-voltage non-reversing unless otherwise indicated.

4. Disconnects: Circuit breaker type.

a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.

b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.

c. Provide auxiliary interlock for disconnection of external control power sources where applicable.

5. Overload Relays: Bimetallic thermal type unless otherwise indicated.

J. Manual Motor Starters:

1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).

2. Configuration: Non-reversing unless otherwise indicated.

3. Fractional-Horsepower Manual Motor Starters:

a. Furnish with toggle operator.

b. Overload Relays: Bimetallic or melting alloy thermal type.

c. Provide means for locking operator in the OFF position.

4. Integral-Horsepower Manual Motor Starters:

a. Furnish with toggle or pushbutton operator.

b. Overload Relays: Bimetallic or melting alloy thermal type.

c. Provide means for locking operator in the OFF position.

K. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:

1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.

2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.

3. Trip-free operation.
4. Visible trip indication.
5. Resettable.
    a. Employ manual reset unless otherwise indicated.
    b. Do not employ automatic reset with two-wire control.
6. Bimetallic Thermal Overload Relays:
    a. Interchangeable current elements/heaters.
    b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
    c. Trip test function.
7. Melting Alloy Thermal Overload Relays:
    a. Interchangeable current elements/heaters.
8. Solid-State Overload Relays:
    a. Adjustable full load current.
    b. Phase loss protection.
    c. Phase imbalance protection.
    d. Ambient temperature insensitive.
    e. Thermal memory.
    f. Trip test function.
    g. Provide isolated alarm contact.

B. Circuit Breakers:

1. Interrupting Capacity (not applicable to motor circuit protectors):
    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Motor Circuit Protectors:

a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.

b. Provide field-adjustable magnetic instantaneous trip setting.

2.4 CONTROL ACCESSORIES

A. Auxiliary Contacts:

1. Comply with NEMA IA 10039.

2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:

1. Comply with NEMA IA 10039; heavy-duty type.

2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.

3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.

4. Indicating Lights: Push-to-test type unless otherwise indicated.

5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:

1. Comply with NEMA IA 10039.

2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:

1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 100 VA spare capacity.

2. Include primary and secondary fuses.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Install all field-installed devices, components, and accessories.

H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 400 amperes. Tests listed as optional are not required.

D. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

END OF SECTION

SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013 (Corrigendum 2015).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

E. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

F. NEMA IS 10033 - Industrial Control and Systems: Adjustable-Speed Drives; 2026.

G. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).

H. NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).

I. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.

J. NEMA MG 00001 - Motors and Generators; 2024.

K. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

N. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

O. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work to avoid placement of ductwork, piping, equipment, and other obstructions within dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate work to provide motor controllers suitable for use with motors.

3. Coordinate work to provide controllers and associated wiring suitable for interface with control devices.

4. Coordinate arrangement of electrical equipment with dimensions and clearance requirements.

5. Verify with manufacturer that conductor terminations are suitable for use with conductors.

6. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.

2. Include wiring diagrams showing factory and field connections.

D. Manufacturer qualification statement.

E. Installer qualification statement.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Manufacturer’s detailed field testing procedures.

H. Field quality control test reports.

I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

J. Executed Warranty: Submit documentation of final executed warranty completed in SUNY's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.9 WARRANTY

A. See Division 01 closeout requirements for additional warranty requirements.

B. Provide minimum 18-month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Variable-Frequency Motor Controllers:

1. Rockwell Automation; Allen-Bradley (Basis of Design)
2. ABB: www.abb.com/#sle.
3. Schneider Electric; Square D Products

2.2 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:

1. Configuration: Packaged controller, nonbypass.
2. Rectifier/Converter: Diode-based, 6-pulse type.
3. Control Method: Vector; open-loop, without feedback.
4. Filtering: Provide input/line reactor and output/load reactor.

D. Controller Assemblies: Comply with NEMA IS 10033, NEMA IS 10034, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA IS 10035, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:

1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
3. Motor nameplate data.
4. Requirements for speed control range, speed regulation, and braking.
5. Motor suitability for bypass starting method, where applicable.

F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

G. Operating Requirements:

1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
3. Efficiency: Minimum of 96 percent at full speed and load.
4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
5. Overload Rating:
    a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
    b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

H. Power Conversion System: Microprocessor-based, pulse width modulation type.
1. Rectifier/Converter: Diode-based, 6-pulse type with input line reactor or DC link choke.

I. Control System:
1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
3. Control Functions:
    a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
        1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
        2) Vector Control: Provide selectable autotuning function.
    b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
    c. Selectable braking control; DC injection or flux braking.
        1) Dynamic Braking: Provide braking chopper circuit and appropriately sized braking resistor where indicated.
    d. Adjustable minimum/maximum speed limits.

e. Maximum output frequency adjustable to not less than 90 Hz; set to the maximum frequency of the approved fan or pump selection (some fans are selected above 60 Hz).

f. Adjustable pulse width modulation switching carrier frequency.

g. Adjustable motor slip compensation.

h. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.

4. Status Indications:

a. Motor run/stop status.

b. Motor forward/reverse status.

c. Local/remote control status.

d. Output voltage.

e. Output current.

f. Output frequency.

g. DC bus voltage.

h. Motor speed.

5. Protective Functions/Alarm Indications:

a. Overcurrent.

b. Motor overload.

c. Undervoltage.

d. Overvoltage.

e. Controller overtemperature.

f. Input/output phase loss.

g. Output short circuit protection.

h. Output ground fault protection.

6. Inputs:

a. Digital Input(s): Three.

b. Analog Input(s): Two.

7. Outputs:

a. Analog Output(s): One.

b. Relay Output(s): Two.

8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.

a. Serial Communications: RS-485; support for Modbus RTU protocol.

b. Ethernet Communications: Support for Modbus TCP and BACnet IP protocol.

9. Features:

a. Password-protected security access.

b. Event log.

J. Power Conditioning/Filtering:

1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.

2. Provide input surge protection.

3. Reactor Impedance: 3 percent, unless otherwise indicated or required.

K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.

1. Disconnects: Circuit breaker or disconnect switch type.

a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.

b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.

c. Provide auxiliary interlock for disconnection of external control power sources where applicable.

2. Provide door-mounted remote operator interface.

L. Service Conditions:

1. Provide controllers and associated components suitable for operation under following service conditions without derating:

    a. Altitude: Less than 3,300 feet.

    b. Ambient Temperature: Between 32 degrees F and 104 degrees F.

2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

M. Short Circuit Current Rating:

1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.

2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

N. Conductor Terminations: Suitable for use with conductors to be installed.

O. Enclosures:

1. Comply with NEMA IA 10030.

2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:

    a. Indoor Clean, Dry Locations: NEMA 12.

    b. Outdoor Locations (rooftop units): NEMA 3R, with thermostatically controlled enclosure heater and ventilation as required by the manufacturer.

3. Finish: Manufacturer's standard unless otherwise indicated.

4. Cooling: Forced air or natural convection as determined by manufacturer.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:

1. Motor Circuit Protectors:

    a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of listed combination motor controller with overload protection; ratings, configurations, and features as indicated or as required.

b. Provide field-adjustable magnetic instantaneous trip setting.

2. Molded Case Circuit Breakers:

a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated or as required.

b. Interrupting Capacity:

1) Provide circuit breakers with interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.

2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.

c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

2.4 ACCESSORIES

A. Auxiliary Contacts:

1. Comply with NEMA IA 10039.

2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each bypass motor starter, minimum.

B. Pilot Devices:

1. Comply with NEMA IA 10039; heavy-duty type.

2. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.

3. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.

4. Indicating Lights: Push-to-test type unless otherwise indicated.

5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control Power Transformers:

1. Size to accommodate burden of contactor coil(s) and connected auxiliary devices.

2. Include primary and secondary fuses.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Install in accordance with NEMA IS 10034 and manufacturer's instructions.

D. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

F. Provide required support and attachment in accordance with Section 26 05 29.

G. Install controllers plumb and level.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Install field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.3 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 400 amperes. Tests listed as optional are not required.

E. Correct deficiencies and replace damaged or defective controllers or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. Training: Train SUNY's personnel on operation, adjustment, and maintenance of controllers and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of two hours of training.

3. Instructor: Manufacturer's authorized representative.

4. Location: At project site.

3.7 PROTECTION

A. Protect installed controllers from subsequent construction operations.

END OF SECTION

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SECTION 26 32 13 - ENGINE GENERATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:

1. Generator set enclosure.

1.2 RELATED REQUIREMENTS

A. Section 23 11 23 - Facility Natural-Gas Piping.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 36 00 - Transfer Switches.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.

C. NEMA MG 00001 - Motors and Generators; 2024.

D. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2018.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 99 - Health Care Facilities Code; 2017.

G. NFPA 110 - Standard for Emergency and Standby Power Systems; 2022.

H. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

I. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.

2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.

3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.

4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.

5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.

1. Include generator set sound level test data.

2. Include characteristic trip curves for overcurrent protective devices upon request.

3. Include alternator thermal damage curve upon request.

B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

1. Identify mounting conditions required for equipment seismic qualification.

C. Manufacturer's equipment seismic qualification certification.

D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

E. Specimen Warranty: Submit sample of manufacturer's warranty.

F. 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 operation of product.

G. Manufacturer's factory emissions certification.

H. Source quality control test reports.

I. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:

1. Certified prototype tests.

2. Torsional vibration compatibility certification.

3. NFPA 110 compliance certification.

4. Certified rated load test at rated power factor.

J. Manufacturer’s detailed field testing procedures.

K. Field quality control test reports.

L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

M. Executed Warranty: Submit documentation of final executed warranty completed in SUNY's name and registered with manufacturer.

N. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70 (National Electrical Code).

2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.

3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).

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

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

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 carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Packaged Engine Generator Set - Basis of Design: Generac

B. Packaged Engine Generator Set - Other Acceptable Manufacturers:

1. Caterpillar Inc

2. Cummins Power Generation Inc

3. Kohler Co

C. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.2 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:

1. Application: Emergency/standby.

2. Configuration: Single packaged engine generator set operated independently (not in parallel).

D. Packaged Engine Generator Set:

1. Type: Gaseous (spark ignition).

2. Power Rating: As indicated on drawings, standby.

3. Voltage: As indicated on drawings.

4. Main Line Circuit Breaker:

a. Type: Electronic trip (LSI); quantity and sizes as indicated. Confirm sizes with the power system study (Section 26 05 73) before ordering.

b. Trip Rating: Select according to generator set rating.

E. Generator Set General Requirements:

1. Prototype tested in accordance with NFPA 110 for Level 1 systems.

2. Factory-assembled, with components mounted on suitable base.

3. List and label engine generator assembly as complying with UL 2200.

4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.

5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

G. Starting and Load Acceptance Requirements:

1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.

2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.

3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).

4. Maximum Load Step: Capable of accepting the largest load step produced by the transfer and load-shed sequence specified in Section 26 36 00, with voltage dip not more than 30 percent and frequency dip not more than 10 percent. Submit the manufacturer's transient performance analysis with the product data.

H. Exhaust Emissions Requirements:

1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.

2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Gaseous (Spark Ignition):

1. Fuel Source: Natural gas.

2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.

3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:

a. Carburetor.

b. Gas pressure regulators.

c. Fuel shutoff control valves.

d. Low gas pressure switches.

C. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motor(s).

2. Battery(s):

   a. Battery Type: Lead-acid.

   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

   c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.

4. Battery Charger:

   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.

   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.

   c. Listed as complying with UL 1236.

   d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.

   e. Provide integral DC output ammeter and voltmeter with five percent accuracy.

   f. Provide alarm output contacts as necessary for alarm indications.

D. Engine Speed Control System (Governor):

1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.

2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:

1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:

1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.

2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.

3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.

2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.4 LOADBANK

A. Provide a remote, roof-mounted resistive load bank recommended by the generator manufacturer, rated not less than 30 percent of the generator nameplate kW rating, in a weatherproof enclosure with integral cooling fan, main breaker and load-step contactors. The unit shall use current transformers to measure generator load and shall be capable of manual and automatic selection of resistive load elements.

B. Load Bank Controller:

1. Provide an automatic load bank controller that adds and removes load steps to keep the generator at or above the manufacturer's minimum recommended load during exercise and operation, with a remote control panel at the location indicated on the drawings for programming and manual load-step selection.

2.5 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 00001; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.

2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.

3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 00001, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 00001, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.6 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:

1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.

2. Generator Set Control Functions:

a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).

b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.

c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.

d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.

e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.

f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).

g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

3. Generator Set Status Indications:

a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.

b. Current (Amps): For each phase.

c. Frequency (Hz).

d. Real power (W/kW).

e. Reactive power (VAR/kVAR).

f. Apparent power (VA/kVA).

g. Power factor.

h. Duty Level: Actual load as percentage of rated power.

i. Engine speed (RPM).

j. Battery voltage (Volts DC).

k. Engine oil pressure.

l. Engine coolant temperature.

m. Engine run time.

n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:

a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:

1) Overcrank (shutdown).

2) Low coolant temperature (warning).

3) High coolant temperature (warning).

4) High coolant temperature (shutdown).

5) Low oil pressure (shutdown).

6) Overspeed (shutdown).

7) Low gas pressure (warning).

8) Low coolant level (warning/shutdown).

9) Generator control not in automatic mode (warning).

10) High battery voltage (warning).

11) Low cranking voltage (warning).

12) Low battery voltage (warning).

13) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:

1) High AC voltage (shutdown).

2) Low AC voltage (shutdown).

3) High frequency (shutdown).

4) Low frequency (shutdown).

5) Overcurrent (shutdown).

c. Provide contacts for local and remote common alarm.

d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:

a. Event log.

C. Remote Annunciator:

1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.

2. Locations shown on the drawings for the remote annunciator and remote emergency stop are suggested. Confirm final locations with the Campus before installation.

3. Generator Set Status Indications:

a. Generator powering load (via position signal from transfer switch).

b. Communication functional.

4. Generator Set Warning/Shutdown Indications:

a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:

1) Overcrank (shutdown).

2) Low coolant temperature (warning).

3) High coolant temperature (warning).

4) High coolant temperature (shutdown).

5) Low oil pressure (warning).

6) Low oil pressure (shutdown).

7) Overspeed (shutdown).

8) Low gas pressure (warning).

9) Low coolant level (warning/shutdown).

10) Generator control not in automatic mode (warning).

11) High battery voltage (warning).

12) Low cranking voltage (warning).

13) Low battery voltage (warning).

14) Battery charger failure (warning).

b. Provide audible alarm with silence function.

c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button on the generator annunciator.

2.7 GENERATOR SET ENCLOSURE

A. Enclosure Type: Level 2 Sound attenuating, weather protective.

B. Enclosure Material: Aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.8 SOURCE QUALITY CONTROL

A. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

B. Generator Set production testing to include, at a minimum:

1. Operation at rated load and rated power factor.

2. Single step load pick-up.

3. Transient and steady state voltage and frequency performance.

4. Operation of safety shutdowns.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 30 00.

F. Provide required support and attachment in accordance with Section 26 05 29.

G. Provide vibration isolation as recommended by the manufacturer. Seismic restraints are not required for this project.

H. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

I. Provide natural gas piping in accordance with Section 23 11 23.

J. Provide grounding and bonding in accordance with Section 26 05 26.

K. Identify system wiring and components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

B. Notify SUNY and Engineer at least two weeks prior to scheduled inspections and tests.

C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

E. Preliminary inspection and testing to include, at a minimum:

1. Inspect each system component for damage and defects.

2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.

3. Check for proper oil and coolant levels.

F. Prepare and start system in accordance with manufacturer's instructions.

G. Perform acceptance test in accordance with NFPA 110.

H. Inspection and testing to include, at a minimum:

1. Verify compliance with starting and load acceptance requirements.

2. Verify voltage and frequency; make required adjustments as necessary.

3. Verify phase sequence.

4. Verify control system operation, including safety shutdowns.

5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).

6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test). Provide load bank for testing.

I. Provide field emissions testing where necessary for certification.

J. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

K. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to SUNY, and correct deficiencies or make adjustments as directed.

B. Training: Train SUNY's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of four hours of training.

3. Instructor: Manufacturer's authorized representative.

4. Location: At project site.

C. After successful acceptance test and just prior to Substantial Completion, replace air and oil filters.

3.6 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

END OF SECTION

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SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:

1. Automatic transfer switches.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 32 13 - Engine Generators: For interface with transfer switches.

1. Includes related demonstration and training requirements.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA IA 10042-1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2025.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2022.

G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.

2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.

4. Coordinate the work with placement of supports, anchors, etc. required for mounting.

5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

C. 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 operation of product.

D. Manufacturer's certification that products meet or exceed specified requirements.

E. Source quality control test reports.

F. Manufacturer’s detailed field testing procedures.

G. Field quality control test reports.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70 (National Electrical Code).

2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

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 carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Transfer Switches:

1. Same as manufacturer of engine generator(s) used for this project.

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.2 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:

1. Utilize open transition transfer unless otherwise indicated or required.

2. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):

a. Unless otherwise indicated or required, provide neutral switching:

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:

1. Transfer Switch Type: As indicated on the drawings.

2. Transition Configuration: As indicated on the drawings.

3. Voltage: As indicated on the drawings.

4. Ampere Rating: As indicated on the drawings.

5. Neutral Configuration: Switched neutral.

6. Load Served: As indicated on the drawings.

7. Primary Source: As indicated on the drawings.

8. Alternate Source: As indicated on the drawings.

F. Comply with NEMA IA 10042-1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

I. Switching Methods:

1. Open Transition:

a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

2. Delayed Transition:

a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

3. Neutral Switching: Either simultaneously switched neutral (break-before-make) or overlapping neutral (make-before-break) methods are acceptable.

4. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

K. Enclosures:

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 12.

2. Finish: Manufacturer's standard unless otherwise indicated.

L. Short Circuit Current Rating:

1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as indicated on the drawings.

M. Automatic Transfer Switches:

1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.

2. Control Functions:

a. Automatic mode.

b. Test Mode: Simulates failure of primary/normal source.

c. Voltage and Frequency Sensing:

1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.

2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.

3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.

d. Outputs:

1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).

2) Auxiliary contacts; two set(s) for each switch position.

e. Adjustable Time Delays:

1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.

2) Transfer to alternate/emergency source time delay.

3) Retransfer to primary/normal source time delay.

4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.

f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.

g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

3. Status Indications:

a. Connected to alternate/emergency source.

b. Connected to primary/normal source.

c. Alternate/emergency source available.

4. Automatic Sequence of Operations:

a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.

b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.

c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.

d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

N. Load Management and Fire Pump Priority Sequence:

1. ATS-LS (life safety branch, NFPA 70 Article 700): Open transition; never shed.

2. ATS-SB (optional standby, NFPA 70 Article 702): Programmed (delayed) transition, with a load-shed input that holds the switch in the neutral (center-off) position.

3. When the fire pump runs on generator power (transfer-switch position and run contacts at the existing fire pump controller), move ATS-SB to the neutral position and shunt-trip enclosed circuit breakers ECB-SB and ECB-SBF, as indicated on Drawings E-502 and E-703.

4. Provide a generator overload/underfrequency load-shed signal from the generator controller to ATS-SB.

5. When the fire pump stops or normal power returns, ATS-SB returns to its normal sequence automatically. Shunt-tripped breakers are reset manually; provide an engraved instruction nameplate at each.

6. Test the complete sequence on generator power in the presence of the Engineer and the Campus; see Section 26 08 00.

2.3 SOURCE QUALITY CONTROL

A. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive transfer switches.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install transfer switches plumb and level.

F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Identify transfer switches and associated system wiring in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Prepare and start system in accordance with manufacturer's instructions.

B. Automatic Transfer Switches:

1. Inspect and test in accordance with NETA ATS, except Section 4.

2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.

C. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. Training: Train SUNY's personnel on operation, adjustment, and maintenance of transfer switches.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

B. Coordinate with related generator demonstration and training as specified in Section 26 32 13.

3.6 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION

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SECTION 26 36 33 - CONNECTION CABINETS FOR PORTABLE GENERATORS AND LOAD BANKS

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

1.2 ABBREVIATIONS AND ACRONYMS

A. QCP: Quick connect panel.

1.3 REFERENCE STANDARDS

A. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

E. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

F. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.

G. UL 891 - Switchboards; Current Edition, Including All Revisions.

H. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.

1.5 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.

C. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

E. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections.

F. Executed warranty.

G. Project Record Documents:

1. Construction, installation, schematic, and wiring diagrams updated to as-installed and commissioned state.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.

2. Requirements of authorities having jurisdiction.

3. Applicable local codes.

B. Manufacturer Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.

2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.

3. Service, repair, and technical support services available 24 hours per day, 7 days per week, 365 days per year from manufacturer or their representative.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.

C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.

D. Inspect products and report damage or violation of delivery, storage, and handling requirements to Engineer.

1.8 WARRANTY

A. See Division 01 closeout requirements for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 24 months from date of shipment. Complete forms in SUNY's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric

B. TRYSTAR

C. Eaton

D. Source Limitations: Provide quick connect power panels and accessories produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.2 QUICK CONNECT POWER PANELS

A. Basis of Design: Trystar DBDS-1

B. Description: Quick connect power panel with provisions for temporary facility connection to portable generators and/or load banks as indicated

C. Listed and labeled as complying with UL 891 or UL 1008. Products listed only to UL 50 are not acceptable.

D. Quick Connect Power Panel:

1. Quick Connect Input/Output Power Panel with Integrated Breaker:

a. Input/Output Configuration: Input (generator), male camlocks.

b. Ground: 20 percent rated.

c. Neutral Configuration, Input/Generator Panel: 100 percent rated.

d. Phase Poles: Three.

e. Ampere Rating: As indicated on drawings.

f. Voltage (for Color Code): Up to 240 V.

g. Enclosure: Type 3R secure.

E. General Requirements:

1. Withstand Current Ratings (WCR): Verified by testing supervised by nationally recognized testing laboratory (NRTL), not by calculation.

2. Input/Output Temporary Camlock Connections:

a. Camlock Connectors: Single-pole, camlock type, series 16.

b. Input (Generator) Camlock Connections:

1) Provide one row of recessed male camlock connectors for every 400 A of capacity or fraction thereof.

2) For each row, provide five camlock connectors (one for each phase, one for neutral, and one for ground).

c. Output (Load Bank) Camlock Connections:

1) Provide one row of female camlock connectors with flip covers for every 400 A of capacity or fraction thereof.

2) For each row, provide four camlock connectors (one for each phase and one for ground).

d. Camlock Connector Color Code:

1) 208Y/120 V (this project):

(a) Phase A: Black.

(b) Phase B: Red.

(c) Phase C: Blue.

2) 440 V to 480 V:

(a) Phase 1: Brown.

(b) Phase 2: Orange.

(c) Phase 3: Yellow.

3) Neutral: White.

4) Ground: Green.

3. Ground: Minimum 25 percent rated.

4. Temporary Cable Provisions:

a. Provide access holes for wiring chamber entry/exit specifically designed for conductors, with bushing or inherent design with no sharp edges that may come in contact with conductor insulation.

b. Arrange connections so that cables drape downward when connected.

5. Enclosure:

a. Construction: Aluminum or steel painted ANSI 61 gray or Type 316 stainless steel as indicated.

b. Comply with UL 50 or UL 508.

c. UL 50E Rating: Type 3R, maintained with temporary cables installed.

F. Quick Connect Input/Output Power Panels with Integrated Breaker:

1. Provide input (generator) or output (load bank) temporary connections as indicated.

2. Available Ratings: 100 A to 4,000 A; up to 600 VAC.

3. Input (Generator) QCPs:

a. Provide phase rotation monitor.

b. Provide 2-wire engine start terminals.

4. Output (Load Bank) QCPs:

a. Provide terminal block for load dump signal.

5. 100 A to 800 A QCPs:

a. Configuration: Wall mounted.

b. Features:

1) Exterior pad-lockable door with provisions for trap key interlock.

2) Deadfront front panel covering exposed parts.

3) Barrier with slots for cable egress.

c. Withstand Current Rating (WCR): Not less than 22 kA.

d. Dimensions: Not to exceed 33 inches wide by 23 inches deep by 48 inches high.

6. 1,000 A to 4,000 A QCPs:

a. Configuration: Pad/floor mounted, with provisions for anchoring.

b. Features:

1) Exterior pad-lockable door.

2) Provisions for trap key interlock on breaker.

3) Divided into upper termination/breaker section with lug terminals for permanently installed conductors and lower cabling section, each with padlockable door.

4) Barrier with slots for cable egress.

c. Withstand Current Rating (WCR):

1) 1,000 A to 1,200 A QCPs: Not less than 22 kA.

2) 1,600 A to 2,000 A QCPs: Not less than 65 kA.

3) 2,500 A to 4,000 A QCPs: Not less than 100 kA.

d. Dimensions:

1) 1,000 A to 1,200 A QCPs: Not to exceed 31 inches wide by 43 inches deep by 77.5 inches high.

2) 1,600 A to 2,000 A QCPs: Not to exceed 37 inches wide by 50 inches deep by 96 inches high.

3) 2,500 A to 3,000 A QCPs: Not to exceed 37 inches wide by 56 inches deep by 96 inches high.

4) 4,000 A QCPs: Not to exceed 41 inches wide by 74 inches deep by 96 inches high.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.

B. Examine for conditions detrimental to completion of work.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer's written instructions.

B. Install quick connect power panels in accordance with NECA 1.

C. Unless otherwise indicated, install and anchor floor-mounted and pad-mounted QCPs on raised concrete pad 4 inches high; see Section 03 30 00.

3.3 FIELD QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Correct deficiencies and replace damaged or defective equipment or associated components.

3.4 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION

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SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 23 00 - Low-Voltage Switchgear.

C. Section 26 24 13 - Switchboards.

D. Section 26 24 16 - Panelboards.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; Current Edition.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

B. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Field-Installed, Externally Mounted Surge Protective Devices:

1. ABB: www.electrification.us.abb.com/#sle.

2. Schneider Electric: www.se.com/#sle.

3. Surge Suppression, LLC (SSI): www.surgesuppression.com/#sle.

B. Factory-installed, Internally Mounted Surge Protective Devices:

1. Same as manufacturer of equipment containing surge protective device, to provide complete listed assembly including SPD.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:

1. Wye Systems: L-N, L-G, N-G, L-L.

2. Three-Phase, Three-Wire Grounded Systems (switchboard MSB and 480 V panels MP4H and KPH3, no neutral distributed): L-L, L-G.

E. UL 1449 Voltage Protection Ratings (VPRs):

1. Equivalent to basis of design.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

1. Indoor clean, dry locations: Type 1.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:

1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.

2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.

1. Switchboards: See Section 26 24 13.

2. Panelboards: See Section 26 24 16.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); Advantage Series; Model SSLB (100 kA/phase, Type 2, I-n = 20 kA); www.surgesuppression.com/#sle.

1. Voltage: As indicated on drawings.

2. Features: Discrete "all-mode" protection (10 modes for 3-phase wye circuits); component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 25 year warranty.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards.

B. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); Advantage Series; Model SSLA (100 kA/phase, Type 2, I-n = 10 kA); www.surgesuppression.com/#sle.

1. Voltage: As indicated on drawings.

2. Features: Discrete "all-mode" protection (10 modes for 3-phase wye circuits); component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 25 year warranty.

C. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.

2. Surge Current Rating: Not less than 100 kA per phase.

3. UL 1449 Nominal Discharge Current (I-n): 10 kA.

4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

5. Diagnostics:

   a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.

   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); Advantage Series; Model SSLA (100 kA/phase, Type 2, I-n = 10 kA); www.surgesuppression.com/#sle.

1. Voltage: As indicated on drawings.

2. Features: Discrete "all-mode" protection (10 modes for 3-phase wye circuits); component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 25 year warranty.

B. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.

2. Surge Current Rating: Not less than 100 kA per phase.

3. UL 1449 Nominal Discharge Current (I-n): 10 kA.

4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

5. Diagnostics:

   a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.

   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

C. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

D. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.3 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 7.19.1.

END OF SECTION

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SECTION 26 51 00 - LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Luminaires.

B. Exit signs.

C. Emergency battery units and remote heads.

D. Exterior luminaires, poles and bases.

E. Ballasts and drivers.

1.2 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 09 23 - Automatic Lighting Controls.

E. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

1.3 REFERENCE STANDARDS

A. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).

B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2011.

H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. Building Code of New York State and Fire Code of New York State; 2025 Editions.

K. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

L. UL 1598 - Luminaires; Current Edition, Including All Revisions.

M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.

3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.

4. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide photometric calculations where luminaires are proposed for substitution upon request.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

a. Include estimated useful life, calculated based on IES LM-80 test data.

b. Include IES LM-79 test report upon request.

2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.

3. Lighting Calculations:

a. Provide full AGI32 based lighting calculations for all areas during the submittal process. Calculations apply to both basis of design manufacturer and/or any substituted fixtures.

b. Calculations shall be submitted in both AGi format and PDF format. AGi Model can be provided to Contractor/Lighting vendor upon request (Engineer Model without fixtures)

c. Engineer reserves the right to slightly adjust lumen packages to meet IES recommendations. These changes area anticipated to be minor and will not impact branch circuit wiring, inverter sizing, etc..

C. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. Provide 3-year manufacturer warranty for LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 MANUFACTURERS - LUMINAIRES

A. Basis of Design: Products scheduled on the luminaire schedule, Drawing E-503.

B. Equivalent products by the following manufacturers will be considered, subject to the Engineer's review of photometric, construction and finish data:

C. Hubbell Brands

D. Acuity Brands, Inc

E. Cooper Lighting Solutions

2.2 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings (basis of design)

2.3 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.

2. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.

2. Tested in accordance with IES LM-79 and IES LM-80.

3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

I. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.

1. LED Tape - General Requirements:

a. Listed.

b. Designed for field cutting in accordance with listing.

J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.4 EXIT SIGNS

A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.

B. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.

1. Number of Faces: Single- or double-face as indicated or as required for installed location.

2. Directional Arrows: As indicated or as required for installed location.

C. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.

2.5 EMERGENCY BATTERY UNITS

A. Description: Self-contained emergency lighting units and remote heads listed and labeled as complying with UL 924; 120 V; types as scheduled on Drawing E-503 (Cooper Sure-Lites SEL25 and AEL246 basis of design).

B. Battery: Sealed, maintenance-free; minimum 90 minutes of emergency operation.

C. Self-Diagnostics: Automatic self-test with status indicator and test switch.

D. Exterior Units: Listed for wet locations, with a cold-weather battery heater where required for the installed location.

2.6 EXTERIOR LUMINAIRES, POLES AND BASES

A. Exterior Luminaires: As scheduled; dark-sky compliant (full cutoff) and listed for wet locations.

B. Poles: As scheduled, with anchor bolts, base covers and handholes. Design the pole, bracket and luminaire assembly for the wind loads of the Building Code of New York State at the project site; submit calculations signed by a professional engineer.

C. Concrete Bases: As detailed on Drawing E-605.

2.7 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).

2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

B. Dimmable LED Drivers:

1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.

2. Control Compatibility: Fully compatible with the dimming controls to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.

2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.

3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.

4. Secure pendant-mounted luminaires to building structure.

5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.

6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.

7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

H. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.

2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

I. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

K. Install accessories furnished with each luminaire.

L. Bond products and metal accessories to branch circuit equipment grounding conductor.

M. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from circuit indicated. Bypass local switches, contactors, or other lighting controls.

N. Remote Ballasts: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.

O. Identify luminaires connected to emergency power system in accordance with Section 26 05 53.

3.4 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

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SECTION 27 05 00 - COMMUNICATION SYSTEM REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes product and installation requirements for unshielded twisted pair cables (UTP) and their associated connectors for horizontal wiring, voice backbone (riser) wiring and fiber optic cable for data risers.

B. The contractor shall provide the necessary skilled labor and supervision to complete all installation tasks including but not limited to: installation of unshielded twisted pair Category 6A cable for data, fiber optic cable, conduits, raceways, cable trays, bridle rings, inner duct, telephone punch blocks, data outlets, telephone outlets their terminations, and testing as required to support the above systems. The contractor shall also provide the labor to paint and mount plywood backboards, and frames, tag and label all cables, label all panel terminations, seal all conduit entrances, test all UTP connectors and place pull ropes in conduits. Successful contractors will quote an installation that includes the installation, operational check, testing and documentation of the complete system. The system is expected to be turn-key and ready for the placement of network electronics by campus technicians.

1.2 REFERENCES

A. National Fire Protection Association (NFPA):

1. 70 National Electrical Code, the following Article:

a. 725 Class 1, Class 2, Class 3 Remote control, signaling, and Power-Limited Circuits.

b. 800 Communications Circuits

B. Telecommunications Industry Association (TIA)/Electronic Industries Association (EIA):

1. TIA/EIA 568 COMMERCIAL BUILDING TELECOMMUNICATIONS CABLING STANDARDS

2. TIA/EIA 568-B.2-1 Transmission Performance Specifications for 4-Pair 100 Ohm Category 6A Cabling

3. TIA/EIA-569 Commercial Buildings Standard for Telecommunications Pathways and Spaces

4. TIA/EIA-606 Administration Standards for the Telecommunications Infrastructure of Commercial Buildings

5. EIA-TSB36 TECHNICAL SYSTEM BULLETIN 36, CABLE SPECIFICATIONS

6. EIA- TSB67 TESTING STANDARDS

1.3 SUBMITTALS (TO BE PROVIDED SEPARATELY TO SUNY CORTLAND NETWORKING AND TELECOMMUNICATIONS FOR REVIEW THROUGH PROJECT COORDINATOR)

A. Provide product data for each type of product specified, including the following:

1. Complete manufacturer's construction details and specifications.

2. Dimensions

3. Characteristics

4. Termination data, including the following:

a. List of materials.

b. Method of connecting cables.

5. Product data for racks, patch panel and room outlet equipment.

B. Submittals Package: Submit the shop drawings, product data, samples, and quality control submittals specified below at the same time, as a package.

1.4 QUALITY ASSURANCE

A. Installers' Qualifications: The persons installing the work of this Section, and their supervisor, shall be personally experienced in Category 6A cable systems and shall have been engaged in the installation of data wiring systems for a minimum of 3 years. Additionally, they should be BICSI certified.

B. If needed, the names and addresses of 5 similar projects which the foregoing people have worked on during the past 3 years should be able to be provided, where requested.

1.5 DELIVERY, STORAGE AND HANDLING

A. Cable Delivery:

1. No cable manufactured over one year prior to site delivery date will be accepted.

2. The following data should be durably marked on each reel:

a. Project title

b. Date of manufacture

c. Manufacturer's name

d. Linear feet

B. Cable Storage: Store where it will be kept clean and dry. Cable should be kept within the temperature range recommended by cable manufacturer for optimum workability.

C. Cable Handling: Handle cable in a fashion to protect it from sharp bends, kinks, crushing or shear forces.

1.6 CURRENT DATA NETWORKING SERVICES

A. The campus communications backbone consists of multimode fiber optic cable (50/125) and single mode fiber optic cable (9/125) run from each building to the Sperry and Smith data centers.

B. SUNY Cortland utilizes IP Telephony for its telephone infrastructure transmissions.

1.7 CABLING INFRASTRUCTURE

A. This section describes the cabling infrastructure required to support the data and telephone systems. All proposals shall include the furnishing and installation of a complete wire and cable distribution system as described final.

B. The building distribution cable plant is a two tiered system consisting of the vertical (riser) tier and the horizontal tier.

1.8 RISER WIRING SYSTEM

A. Vertical (riser) wiring is the portion of the wiring system that extends from the MDF in building to each wiring closet (IDF) and is connected to patch panels mounted in racks.

B. Twenty four (24) Single-mode fiber optic cables will installed by the contractor in each Data IDF location to facilitate the transmission of data from the MDF to the IDF. These cables will be terminated, tested and installed (in an approved enclosure) by the contractor. Test results shall be provided to SUNY Cortland Networking and Telecommunications for Campus approval.

1.9 HORIZONTAL WIRING SYSTEM

A. Horizontal wiring is the portion of the wiring system that extends from each data communications outlet or voice outlet to a patch panel in a communications closet (IDF). The horizontal distribution wiring system provides connectivity between IDFs and rooms/areas so designated by the specifications.

B. Category 6A cables will be run to each office location as shown on drawings. Appropriate cables will be pulled to each classroom/common area as indicated on drawings.

C. The system also consists of communication racks, UTP category 6A patch panels, UTP category 6A patch cords, data communication outlets, telephone outlets, conduits to corridor ceiling capabilities, cable tray, bridle rings, cable guides. All raceways, cable, patch panels,

connectors, communications enclosures, and wall jacks used on this project are to be provided by the contractor. Any rack installed must be able to accept a device that is 24 inches deep.

D. The newly installed horizontal data wiring system will be totally category 6A compliant and will be rated for speeds of 10 Gbps. All patch panels and modular wall terminations will follow the standards for T568B.

1.10 LABELING AND RACK LAYOUT

A. Cables shall be labeled according to EIA-TIA 606A standard. For example, the wall jack from the first port in the first panel if IDF 195A would be identified as 195A-1A01. Panel jacks shall be grouped and identified sequentially by room number and installed in ascending numerical order from left to right, top to bottom across patch panels.

B. Patch panels shall be laid out in accordance with Campus standards. Coordinate prior to installation each MDF/IDF proposed rack layout. Each panel jack shall also be mechanically labeled to indicate the room number where the cable and wall jack are terminated. Consult SUNY Cortland Networking and Telecommunications for approval of proposed rack layout prior to beginning work.

1.11 PATCH PANELS AND CONNECTIVITY

A. Patch panels will be rack mounted in floor mount racks providing a place for permanently terminating vertical and horizontal wring in closets and equipment rooms and provide the means to connect (patch) the horizontal wiring to the system equipment and wiring.

B. Category 6A RJ45 connectors will be compliant with EAI-TIA TSB-40 for terminating four unshielded twisted pair for Ethernet and other applications.

1.12 TYPICAL DROP TYPES

A. Standard Building UTP Drop: A standard building UTP drop contains a single UTP Category 6A cable that terminate “B” Standard in a stainless steel faceplate with one orange RJ-45 jack and one spare blank port.

B. Wireless UTP Drop: SUNY Cortland uses wireless (WiFi) devices that are powered over the campus data network. These devices require one UTP category 6A cable that terminate to “B” Standard orange RJ-45 jacks. Ceiling mounted double gang box is preferred installation.

C. Presentation Equipped Spaces:

1. Projector- two data drops.

2. Flat panel- four data drops.

3. Instructor station- six data drops.

4. Individual camera and microphone locations- one data drop.

D. Building Automation Control System Drop: At all Energy Management / Building Management equipment that requires an Ethernet Drop connection as required by Section 23 09 23 provide Standard Building UTP Drop adjacent the Energy Management / Building Management System device to be connected. This UTP drop would be the demarcation point between the campus network and the Energy Management / Building Management System network. Provide while-in-use cover, standard building UTP drop containing the required UTP category 6A cables that terminate “B” Standard in a Stainless-steel faceplate with two orange RJ-45 Jacks for device and application required by Building Automation Control System. Label face plate and cover with IDF Room Number, Panel and Port.

1.13 ELECTRICAL REQUIREMENTS

A. At every IDF location, 2 duplex receptacles on their own 20 A breaker shall be provided. The circuits shall be contained in a standby (generator-backed) panel. Additionally, 2 duplex receptacles on their own 20Amp breaker shall be provided that are not on standby power.

B. At the MDF location, a 20Amp breaker shall be provided and attached to the power strip within the network electronics closet. The circuit shall be contained in a standby (generator-backed) panel. Additionally, 2 duplex receptacles on their own 20 A breaker shall be provided that are not on standby power.

1.14 CONFERENCE ROOMS:

A. Conference tables shall be supplied with appropriate network and electric provisioning from below via floor mounted through box.

PART 2 – PRODUCTS

2.1 UNSHIELDED TWISTED PAIR (HORIZONTAL) CABLE - CATEGORY 6A

A. Cable shall be constructed of 8, 23/24 AWG solid copper conductors, individual pairs variably twisted to form 4 pair cable. (“Bonded pair” type cable preferred for renovations.)

B. Cable shall be Plenum rated unless otherwise approved.

C. Cable shall meet or exceed EIA/TIA 568, TSB36, Category 6A for 100 ohm UTP cable.

D. Make: Belden 10GXS or Berk-Tek LANmark-10G2 (Category 6A UTP)

2.2 RISER (BACKBONE) CABLE: FIBER OPTIC – DATA 24 STRAND 9/125 SINGLEMODE

A. Provide high visibility jacketed fiber, or display “DANGER: fiber optic” stickers along cable jacket to visibly identify cable.

B. In each manhole/pull box, cable shall be identified with start and end locations, date of installation and installer name. This tag shall also include the foot marking at which it is installed.

C. Basis of Design

1. Tight buffer type cable

2. 24 strand SM OS2

3. General Cable XX0241PNU

2.3 MODULAR JACK – DATA OUTLETS

A. RJ45 modular jacks shall be 8wire, with 24 AWG solid conductors, each contact surface shall have a minimum 50 micro inches gold coating with insulation displacement terminations which meet or exceed EIA/TIA 568, Category 6A Classification. Jack color shall be Orange.

B. RJ45 modular jacks shall be wired in accordance with EIA/TIA T568B.

C. Data jacks must be of the “rear-loading” type and cannot be installed by pressing jack through front of faceplate.

D. Basis of Design: Hubbell HJU6A (Color per Drawing Schedule)

2.4 WIRE MANAGEMENT - DATA

A. Provide vertical wire management.

B. Make: Panduit, Siemon, AMP, Hubbell.

2.5 DATA OUTLETS

A. Provide a single gang face plate with 2 data.

B. Provide 2 orange modular jacks T568B, Category 6A - complete with all required termination accessories.

C. Basis of Design: Hubbell

2.6 DATA PATCH PANELS

A. Provide appropriate number of Category 6A patch panels to accommodate all wiring runs.

B. Panels must be 24 or 48 port modular Keystone jack termination. Must accept Hubbell Cobra-lock jack.

C. Patch panels shall accommodate 48 terminations in a 2 rack unit panel.

D. Cables shall be terminated in a manner that does not necessitate horizontal wire management panels.

E. Consult SUNY Cortland Networking and Telecommunications for desired layout of rack at termination time.

2.7 FIBER OPTIC PATCH PANELS

A. Rack mounted, 19" flanges

B. Steel enclosure

C. High density

D. Provide shop drawing for approval showing correct product selection at MDF and each IDF, sized to handle all proposed FOC.

E. Basis of Design: Panduit HD Flex Fiber Panels and HD Flex Fiber Cassettes and Adapter panels.

2.8 DATA RACKS

A. 2 post, black finish

B. Open Style

C. Dimensions: 6' tall (38ru), 72" x 20.25"

D. nVent or equal

2.9 RACK MOUNTED PDU'S

A. Provide two PDUs per rack, one for each rack receptacle indicated on the drawings:

B. PDU 1: 120 V, 20 A, NEMA 5-20P input, (10) NEMA 5-20R outlets

C. PDU 2: 208 V, 30 A, NEMA L6-30P input to match the L6-30R rack receptacle indicated; outlet types and quantity as directed by Campus IT.

D. Basis of Design (PDU 1): nVent RPP110R20AP110

2.10 IDF CLOSETS

A. Contractor will provide racks in the IDF for mounting and wiring network supported hardware, network electronics and telephone cross connect blocks.

PART 3 – EXECUTION

3.1 PREPARATION

A. Before installing cable, test all reels to verify that the cable is intact.

3.2 INSTALLATION

A. Intra-Building Cable Runs:

1. Horizontal UTP data cable runs shall not exceed industry standard of 90 meters.

2. All existing raceways or cable trays may be used for the cable whenever practical providing maximum allowable capacity for this project is not exceeded. Contractor will ensure the use of these conduits and cable trays does not damage any of the existing plant. Maximum allowable raceway capacity is seventy five percent (75%).

3. The Contractor shall provide the most effective location for the placement of raceways or cable trays. Exposed raceways, if allowed, shall match the original finish of the hallway, room, etc. The exact location of all proposed new raceways or cable trays shall be approved by the Project Manager prior to installation.

4. All floor and wall penetrations will be fire-stopped after cabling is installed with intumescent fire caulk or approved alternative. Sleeves will be installed in all wall penetrations along the cable path.

5. All riser cable paths must be metal conduit or closed raceway, except in those areas that are secure from student population or above drop ceilings.

6. Cables that are located in non-publicly accessible areas and are not in conduit or raceway will be neatly and securely bundled and fastened to the building ceiling and walls via saddle style bridle rings. No exposed cabled cables are allowed in publicly accessible areas.

7. Abandoned Cable: Abandoned cable in existing conduits may be used as pull wires. Abandoned cable is defined as cable that has been completely severed on one end. All abandoned cable should be removed from conduit and disposed of. Coordination shall be made with SUNY Cortland Networking and Telecommunications.

8. Leave minimum 2’-0” service loop at patch panel.

9. In new conduit, fabric/textile inner-duct must be used to allow for maximum fill ratio of conduit.

B. Unshielded Twisted Pair Terminations:

1. Wiring pin-outs shall conform to T568B Standards.

2. All data station terminations shall terminate in UL Category 6A RJ45 orange modular wall jacks.

3. Where appropriate, double gang outlet boxes and face plates may be used.

4. Placement of data jacks in each room shall conform to EIA/TIA 569 standards.

5. When RJ45 wall jack is mounted vertically, the locking tab shall face down.

6. When RJ45 wall jack is mounted horizontally, the locking tab shall face to the

7. right.

8. IDF terminations shall be rack mounted Category 6A UTP patch panels.

C. Identification of Fiber Optic Cables; label in accordance with TIA 606 including:

1. 1. Identify cables in pull-boxes and in equipment to which they connect.

2. Install tags on each cable indicating cable number, date installed (month/year), type of cable, manufacturer and foot marker.

3. 3. Use markers to identify each cable in equipment to which they connect.

3.3 FIELD QUALITY CONTROL

A. UTP Cabling:

1. The Contractor will test each UTP cable for continuity, shorts, or crossed conductors, verification of length and termination integrity.

2. Written certification of test results is required as part of the completion of the project. Documentation shall be provided to SUNY Cortland Networking and Telecommunications.

3. The Contractor guarantees that the data cable plant will meet the performance standards for UL Category 6A including but not limited to attenuation, near end crosstalk, impedance, capacitance, and transmission throughput for one year.

4. Minimum bend radius for the cable shall not be violated.

5. Only Hook and Loop tape, ties or straps are to be used in closets. They should be of adequate length to accommodate for future expansion.

6. Maximum tensile loads per manufacturer’s recommendation for cable provided shall not be exceeded during installation. Perform installation using slip clutch pulling apparatus or using acceptable tension monitoring equipment.

7. Cables shall not be subjected to crushing from tools, equipment, people or vehicles.

8. Install all cables in continuous lengths from point of origin to point of destination. No fiber splicing, coupling, breaking or opening of the cable jacket shall be permitted without the express written consent of the Project Manager. In the event of such warranted consent, fiber splices shall be fusion type. Neatly coil and bind slack cable. Do not violate minimum bend radius.

9. Provide bracing, hangers, or other accessories as required to provide firm, rigid attachment.

10. Route cables to patch panels as required minimizing chances of accidental damage from other cables, objects, or maintenance operations.

11. Support raceways, racks, cables and other equipment under the provision of other reference sections.

12. Provide labeling of all components, cables, face plates, racks, patch panels, IDFs in accordance with EIA/TIA 568. Printed layout sheets directing cable identification are NOT acceptable. Each port must be individually and mechanically labeled.

13. In so far as possible, all cable, conduit, raceways, etc., shall be concealed from view. In general, run cables in concealed space above finished ceilings. Provide access doors where new ceiling space is inaccessible or access points are inadequate. Painted, exposed conduit is acceptable for rooms with exposed structure as ceiling. In framed walls, fish partition cavity from ceiling space to drop location. Metal surface mount raceway is acceptable for masonry walls. All distribution facilities shall be installed in such a manner to prevent vandalism and be visually unobtrusive.

14. All cable installations, terminations and attachments shall have suitable strain relief.

15. The College requires that each cable, conduit, terminal enclosure and specified equipment associated with the new distribution system(s) be permanently imprinted with a form of identification tag. This identification shall also be placed on any portion of the existing system(s) that are approved for re-use (i.e. vacant conduit, cable re-use, backboards, etc.). The cable identification plan shall be distinct and provide color coding for each separate cable media that is installed and indicate the plant as College property. The contractor shall develop the identification plan and submit this plan, including samples of proposed materials, to the College for approval not less than thirty (30) days prior to the commencement of installation.

16. Install terminations, patch panels, and data communications floor mounted racks as per manufacturer’s recommendations. Install plumb and attached securely at each corner.

    a. Fiber optic patch panel shall be mounted in 19” floor mounted rack enclosures. Install cable into rack mounted patch panel.

    b. All floor mounted racks must be securely mounted to the floor

17. All damage accidental or otherwise caused by installation shall be repaired and all surfaces, fixtures, etc. shall be restored to their original condition prior to the damage.

B. Date of Acceptance:

1. The Contractor must provide an inventory of all components provided at each acceptance phase. This inventory will include all components and modules, cables, patch cables, patch panels, etc. by model number, serial number, release and quantity, certification and testing documentation.

C. Loss on or Before Acceptance Date:

1. In the event that the equipment or any material is damaged, lost, stolen, or destroyed prior to acceptance by the College, the Contractor shall promptly repair or replace such equipment at no expense to the College, if such repair or replacement can be accomplished by a date necessary to comply with the agreed upon acceptance testing schedules. However, in the event that repairs or replacements cannot be accomplished by a date necessary to allow compliance with the acceptance schedule, the Contractor should notify the College, and the College can either:

a. Accept the delay or,

b. Accept delivery and installation of the equipment, as is, together with the Contractor's ratable portion of all insurance proceeds paid or payable thereon as a result of the loss, damage, or destruction, in which case the contract should remain if full force, or

c. Adjust the acceptance testing dates to such dates that are mutually agreed upon in wiring by the Contractor and the College.

3.4 TESTING

A. Testing shall be fully completed and system shall be acceptable for use by the Campus prior to mechanical system BMS commissioning activites. Contractor shall coordiante in the field and ensure that the system described/covered in this Div. 27 specification has been fully installed and tested in a timely manor that does not hold up or delay BMS Cx activities.

B. The College requires that all tests described below be performed by the Contractor. The Contractor shall provide all testing/diagnostic equipment and software. The Contractor shall document all test results and provide copies to SUNY Cortland Networking and Telecommunications. Individuals from SUNY Cortland Networking and Telecommunications will be present for a portion of the testing. Contractor shall notify Project Coordinator when testing is to be performed.

C. All cable (telephone, UTP, Fiber Optic) specifications shall be verified with the owner prior to installation. This will ensure that the cable is of the proper type ordered, experienced no damage during shipping, and meets the manufacturers' specifications. All cable shall be tested

after installation to ensure that the cable has retained its integrity and no faults were introduced during installation.

D. UTP Cabling:

1. The Contractor will test each UTP cable for continuity, shorts or crossed conductors, verification of length and Termination integrity.

2. Written certification of the test results is required as part of the completion of the project.

3. The Contractor guarantees that the data cable plant will meet the performance standards for UL Category 6A including but not limited to attenuation, near end crosstalk, impedance, capacitance, and transmission throughput for one year.

3.5 MAINTENANCE AND SUPPORT

A. This section describes the maintenance and support, warranties, guarantees and documentation requirements of the Project.

B. Maintenance and Support

1. Warranty Requirement:

a. New cable and wire distribution system(s) shall be warranted for a minimum of five (5) years following expiration of the initial one year guarantee.

b. During the warranty period, the College requires that the Contractor replace or repair all defective items covered by the Warranty and/or maintenance contract at no cost to the College. The Contractor shall provide all system maintenance during the warranty period at no cost to the College and utilize full-time employees of the Contractor’s organization.

2. Basic Maintenance Support:

a. The Contractor shall provide a detailed description of support services for both the Warranty period and maintenance period. Support service shall include, but not be limited to:

1) 800 telephone number used for systems support, maintenance, escalation, etc.

2) Call response by a certified technician must be made within 24 (twenty-four hours) of the request for service.

3.6 MATERIAL SPECIFICATIONS

A. General: Manufacturers of products have been listed for the purposes of defining a standard for quality and capability. Products from other manufacturers are acceptable providing they meet or exceed the quality of those that have been stated.

1. UTP Category 6A Cable: Acceptable manufacturers: Belden, Berk-Tek.
2. UTP Termination Panels: Acceptable manufacturers: Siecor, Hubbell, AMP, Interlink.
3. Communication Enclosures, Open Bay Racks: Acceptable manufacturers: Great Lakes, Hubbell, Chatsworth.
4. Data Outlets: Acceptable manufacturers: Hubbell – data HJU6A.
5. General: All data UTP Hardware: Certified Category 6A performance.
6. Faceplates: Stainless Steel with the appropriate quantity of openings sized to fit Hubbell Cobra lock jacks.
7. Inner-duct (fabric and plastic): Acceptable manufacturers: any.
8. Raceway/Wiremold: Acceptable manufacturers: Hubbell, Panduit, Wiremold.
9. Bridle Rings (with saddle): Acceptable manufacturers: Minerallac, B-Line.

3.7 WARRANTY

A. The installed cable infrastructure shall be warranted for the following:
   1. Against all defects of workmanship and materials in the system for a period of Fifteen (15) years after acceptance and cutover.
   2. To meet any and all specifications stated in this document and as presented in all system documentation.

B. The contractor agrees to repair or replace, if repair cannot be completed to the client's satisfaction, within thirty (30) days' notice that a failure has occurred, all defective components of the system. Any replaced component will be of the same quality and type and carry the remainder of the above system warranty.UU

C. Contractor warrants Communication Cable System in writing against defects in workmanship and material for a period of fifteen (15) years after acceptance. During this time, the entire Cable System is to be kept in operating condition at no additional labor or material cost to the Owner.

D. Acceptance in writing, only after the project is fully completed and tested in accordance with the Specifications and Contract Drawings and to the satisfaction of the Owner or duly authorized representative.

E. Contractor assumes responsibility for quality and satisfactory operation of components and materials not manufactured by the contractor; submit guarantee endorsed by the manufacturer of materials.

F. Whenever a guarantee of durability, operating capacity or proper functioning are noted, the contractor shall furnish all manufacturer detailed drawings and test certificates.

G. All warrantees provided by the manufacturers shall be extended to the Owner and certified in writing.

-END OF SECTION-

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal cable tray systems:

1. Metal ladder cable tray.

2. Metal wire mesh/basket cable tray.

1.2 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

B. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.

C. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition; 2022.

D. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.

E. BICSI N3 - Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure; 2020.

F. BICSI TDMM - Telecommunications Distribution Methods Manual, 15th Edition; 2024.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

H. NECA/BICSI 607 - Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings; 2011.

I. NEMA BI-50016 - Cable Tray Installation Guidelines; 2024.

J. NEMA BI 50015 - Metal Cable Tray Systems; 2024.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

M. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2021).

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts. Coordinate work to avoid installation of obstructions within cable tray required clearances.

2. Coordinate arrangement of cable tray with dimensions and clearance requirements of actual products to be installed.

3. Coordinate work with placement of supports and anchors required for mounting.

4. Notify of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.

C. Sequencing:

1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.5 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.

C. Shop Drawings: Include dimensioned plan views and sections indicating proposed cable tray routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.1 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

A. Provide new cable tray system consisting of required components, fittings, supports, and accessories, as necessary for complete system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.

D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under service conditions at installed location.

E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (i.e., no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA BI 50015.

F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA BI 50015 including applicable allowable tolerances.

2.2 METAL CABLE TRAY SYSTEMS

A. Manufacturers:

1. Chatsworth

2. ABB, Inc: www.new.abb.com/#sle.

3. Cablofil, a brand of Legrand North America, Inc: www.legrand.us/cablofil/#sle.

4. Cope, a brand of Atkore International Inc: www.copecabletray.com/#sle.

5. Substitutions: See Division 01 product requirements.

B. Comply with NEMA BI 50015.

C. Material/Finishes:

1. Zinc Electroplated Steel: Comply with ASTM B633.

2. Mill-Galvanized Before Fabrication (Pre-Galvanized) Steel: Comply with ASTM A653/A653M, G90 coating.

D. Metal Ladder Cable Tray:

1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
2. Load/Fill Depth: As indicated on drawings.
3. Span/Load Rating: NEMA VE 1 Class 10A.
4. Rung Spacing: 9 inches on center for straight lengths.
5. Inside Width: As indicated on drawings.
6. Inside Radius of Fittings: 12 inches.

E. Metal Wire Mesh/Basket Cable Tray:

1. Material: Zinc-electroplated steel or mill-galvanized before fabrication (pre-galvanized) steel.
2. Tray Depth: As indicated on drawings.
3. Span/Load Rating: 50 lb/ft at span of 10 ft.
4. Mesh Spacing: 2 by 4 inches.
5. Tray Width: As indicated on drawings.

2.3 SOURCE QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Metal Cable Tray: Perform factory design tests in accordance with NEMA BI 50015, including electrical continuity and load testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage cable tray system has been completed.

B. Verify field measurements.

C. Verify dimensions and span/load ratings of cable tray system components.

D. Verify that mounting surfaces are ready to receive cable tray and associated supports.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install cable tray system in accordance with the following. Where requirements differ, comply with most stringent.

1. BICSI ITSIMM (technology systems).

2. BICSI N1 (cabling infrastructure).

3. NECA 1 (general workmanship).

4. NEMA BI-50016 (cable tray).

C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.

D. Arrange cable tray to provide required clearances and maintain cable access.

E. Install cable tray plumb and level, with sections aligned and with horizontal runs at specified elevation.

F. Metal Wire Mesh/Basket Cable Tray: Field fabricate fittings in accordance with manufacturer's instructions, using only manufacturer-approved connectors classified for bonding.

1. Inside Radius of Fittings: 12 inches.

G. Cable Tray Movement Provisions:

1. Provide expansion fittings where cable tray is subject to movement, including but not limited to:

a. Where cable tray crosses structural joints intended for expansion.

b. Long straight cable tray runs in accordance with NEMA BI-50016.

2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA BI-50016.

3. Set gaps for expansion fittings in accordance with NEMA BI-50016.

H. Cable Provisions:

1. Use fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.

2. Use drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.

3. Use cable support fittings for long vertical cable tray runs with heavy cables.

I. Provide end closures at unconnected ends of cable tray runs.

J. Cable Tray Support:

1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA BI-50016, BICSI ITSIMM, and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment where not furnished by cable tray manufacturer.

2. Provide support within 24 inches of each side of connection to a bend, tee, or cross in accordance with TIA-569, unless otherwise approved by Engineer.

3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

K. Grounding and Bonding Requirements:

1. Install cable tray grounding in accordance with the following. Where requirements differ, comply with the most stringent.

a. BICSI ITSIMM (technology systems).

b. BICSI N3 (cabling infrastructure).

c. BICSI TDMM (telecommunications distribution methods).

d. NECA/BICSI 607 (telecommunications bonding and grounding).

e. TIA-607 (generic telecommunications bonding and grounding).

2. Metal Cable Tray Systems: Use suitable bonding jumpers or classified cable tray connectors to provide electrical continuity. Do not use classified cable tray connectors where cable tray sections have been modified, such as being bent, cut, or reshaped.

3. Provide suitable bonding conductor in each metal cable tray. Do not use cable tray as sole bonding conductor.

a. Bonding Conductor for Galvanized Steel Cable Tray: Use bare or insulated copper conductor.

b. Minimum Bonding Conductor Size:

1) Conductor Lengths up to Up to 100 ft: 6 AWG.

c. Do not decrease bonding conductor size as bonding path moves closer to intersystem bonding termination device/busbar.

d. Bond cable tray bonding conductor to each metal cable tray section using suitable listed ground clamps. Separate bonding jumpers are not required where properly bonded cable tray bonding conductor provides equivalent continuity.

4. Bond cable tray and/or cable tray bonding conductor to Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB) at each termination location.

5. Where mesh bonding network (Mesh-BN) is installed, bond cable tray to Mesh-BN.

L. Conduit Termination:

1. Use listed cable tray conduit clamps (evaluated for bonding connection) to terminate conduits at cable tray.

2. Provide insulating bushing at conduit termination to protect cables.

3. Provide independent support for conduit.

M. Cable Installation:

1. Install cables in accordance with the following. Where requirements differ, comply with most stringent.

a. BICSI ITSIMM (technology systems).

b. BICSI N1 (cabling infrastructure).

c. NEMA BI-50016 (cable tray).

2. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.

3. Use cable clamps or cable ties to fasten conductors/cables to vertical and horizontal runs of cable tray.

a. Distance Between Fastening Points for Vertical Runs: 18 inches.

b. Distance Between Fastening Points for Horizontal Runs: As required to maintain spacing and confine conductor/cable within cable fill area.

N. Penetrations: Install firestopping to preserve fire resistance rating of building elements.

O. Identification Requirements:

3.3 FIELD QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Inspect cable tray system for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective cable tray system components.

3.4 ADJUSTING

A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Remove dirt and debris from cable tray.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 PROTECTION

A. Protect cable tray system from subsequent construction operations.

END OF SECTION

SECTION 27 41 23 - EMERGENCY RESPONDER RADIO COVERAGE SYSTEM (ERRC)

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bi-directional amplifier (BDA) system with donor antenna, fiber-optic backbone, floor head-end units, remote antennas, monitoring, and NFPA 72 acceptance testing to provide 95 % general area and 100 % critical area coverage for emergency responder radio communications.

B. Related Requirements

1. Section 27 05 00 - Communication System Requirements.

1.2 REFERENCES

A. 2025 FCNYS §510 – Emergency Responder Radio Coverage

B. NFPA 72 – 2022 Edition, Chapter 24

C. NFPA 1225 – 2022 Edition (formerly NFPA 1221)

D. SUNY Directive 28-1 §7.D (latest revision)

E. UL 2524 – In-Building 2-Way Emergency Radio Communication Enhancement Systems

1.3 SYSTEM DESCRIPTION

A. Hybrid fiber/coax distributed antenna system (DAS) for 700/800 MHz public safety bands.

B. RF coverage study bypassed per SUNY Directive 28-1 §7.D (campus precedent).

C. BDA Location: Penthouse 5005 (fourth floor penthouse).

1.4 SUBMITTALS

A. Product Data: BDA, donor antenna, head-end units, remote antennas, fiber, coax.

B. Shop Drawings: Floor plans (marked repeater locations), riser diagram (Drawing E-708).

C. RF Coverage Prediction (iBwave or vendor model) – for information only.

D. Test Reports: NFPA 72 grid test results (95 % / DAQ ≥3.0).

E. Vendor confirmation letter that layout and BOD meet coverage requirements.

1.5 QUALITY ASSURANCE

A. Installer: Minimum 5 years documented ERRC experience, FCC GROL certified technicians.

B. Manufacturers: Regular production of public-safety DAS with UL 2524 listing.

PART 2 PRODUCTS

2.1 MANUFACTURERS - BASIS OF DESIGN

A. Westell Technologies (GraniteCore series) – Basis of Design.

2.2 BI-DIRECTIONAL AMPLIFIER (BDA)

A. Westell GraniteCore CSG-700/800.

B. Dual-band 700/800 MHz, Class A or B, minimum 2 W composite power per band.

C. NEMA 4 wall-mount cabinet with 12-hour battery backup.

D. Power: Dedicated 120 V, 20 A branch circuit from life safety panel LS4, with a lockable breaker marked in red and identified as the ERRCS circuit.

E. Integrated annunciator and remote monitoring via dry contact and SNMP/Ethernet.

2.3 DONOR ANTENNA

A. Comba AO-700/800-OMNI.

B. Omnidirectional, 6 dBi gain, roof mounted on non-penetrating sled, lightning protected

2.4 FLOOR HEAD-END UNITS

A. Comba RH7W22R783348 (4-port) or RH7W22R783349 (8-port).

1. 1 fiber IN (SC/APC duplex), 4 or 8 fiber OUT ports, daisy-chain capable

2.5 REMOTE ANTENNAS

A. Comba RDU-800.

B. Ceiling-mount omnidirectional, low-profile white finish.

C. Quantity: 25 total (locations shown on drawings).

2.6 BACKBONE CABLING

A. Donor Coax: RFS DragonSkin ½ in, UL 2196 2-hour CI, plenum rated.

B. Fiber Backbone: 12-strand 50/125 micron multimode (OM3) fiber optic cable, indoor/outdoor rated and suitable for direct burial, listed for the spaces where installed; Corning ClearCurve or equal; installed in Maxcell 4-cell fabric innerduct in 4 inch conduit as indicated on Drawing E-708.

C. Coax Drops: Times Microwave LMR-400-FR or approved equal, maximum 60 ft per remote.

2.7 ACCESSORIES

A. Battery backup, fiber splice trays, coaxial lightning arrestors, mounting hardware.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount BDA in Penthouse 5005; provide the dedicated circuit from panel LS4.

B. Connect the head-end units to the BDA over the 12-strand multimode backbone as indicated on Drawing E-708.

C. Maximum 60 ft LMR-400-FR from any head-end to remote antenna.

D. Route all cabling in compliance with pathway survivability requirements..

3.2 EXAMINATION

3.3 FIELD QUALITY CONTROL

A. Perform NFPA 72 Chapter 24 grid test (24 in × 24 in tiles).

B. Testing witnessed by Owner, SUNY FM, and AHJ.

3.4 SYSTEM STARTUP

A. Manufacturer Services: Provide services of manufacturer's field representative to perform systems startup.

B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

3.5 CLOSEOUT

A. Provide as-built drawings, test reports, and 2-year warranty on all equipment.

B. Demonstrate operation of equipment to SUNY's designated representative.

C. Training: Train SUNY's personnel on operation and maintenance of system.

1. Training Reference: Operation and maintenance manual and additional training materials as required.

2. Provide minimum of two hours of training.

END OF SECTION

SECTION 27 51 19 – SOUND MASKING SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

A. The Contractor shall supply and install an electronic masking sound system of excellent quality and in good working order as specified. The system shall provide masking sound capability in part of the 4th floor of the renovated Corey Union Building on the campus of SUNY Cortland.

B. The system shall comprise a network of individually-addressable loudspeakers or groups of loudspeakers, with random a noise generator input signal as well as equalization and amplification capabilities. The system shall be capable of introducing broadband masking sound into designated areas.

C. The central controller shall be installed in IDF 4095A. This room shall also house equipment needed to provide power to the masking loudspeakers. This location is shown on Drawing SM-101.

D. The specified placement and output level of masking loudspeakers is shown on Drawing SM-101.

E. Upon completion and contractor tuning of the installation, the system will be tested and final adjustments will be made by the architect's representative, Ostergaard Acoustical Associates, consultants in acoustics, 1460 US Highway 9 North, Woodbridge, New Jersey 07095. The presence and assistance of the Contractor is required during these tests.

F. Notwithstanding the detailed information in this specification, it is the responsibility of the Contractor for verifying the completeness of the parts list, the correctness of the type numbers, and to supply a working overall system meeting these specifications.

1.3 QUALIFICATIONS FOR PROFESSIONAL SOUND CONTRACTORS

A. To be considered technically qualified for this project, the Contractor shall be approved by the manufacturer of the selected masking system hardware.

1.4 GENERAL CONTRACT CONDITIONS

A. Where applicable, the Contractor shall apply and pay for all permits and inspections required. Work shall be done in compliance with laws, rules, ordinances, and regulations having jurisdiction. The Contractor will be held responsible for any damage to existing structure or work executed by other trades that is caused by Contractor, Contractor's

employees, and applicable sub-contractors. All equipment components and wiring required by this specification and the installation shall conform to applicable electrical and building codes in effect at the time of installation. The installation of all equipment components and wiring shall be neat and tidy. All boxes, racks, equipment, etc., shall be plumb and square. The Contractor shall watch for conflicts with work of other contractors on the job and execute, without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment. The Contractor shall supply all items listed of quality designated and quantity required and provide necessary labor and incidentals to ensure proper installation in accordance with this specification.

PART 2 – EQUIPMENT

2.1 GENERAL

A. Equipment shall be as specified in this section. Materials specified without a manufacturer shall be of professional quality. No used equipment or materials shall be installed.

2.2 CONTROL PANEL AND AMPLIFIERS

A. Devices shall control masking sound, paging, and timing functions, and shall be capable of interfacing with network devices, other control panels, and a computer. Control housing shall comprise a locked, wall-mounted metal enclosure or a rack-mountable device. Masking sound generator shall be available with 23-band one-third octave equalization, , gain controls for masking and paging, and signal paths compatible with specified control device and loudspeakers. Masking sound generator shall be a professional quality random noise generator with no noticeable repetitive pattern. Gain control for the masking signal shall be adjustable in steps no larger than 0.5 dB from a minimum of 35 dB(A) at 1 meter from loudspeaker assembly to at least 70 dB(A) at 1 meter.

B. Representative Quality:
- LogiSon Network Control Panel NCP-2 with Primary Network Hub PNH-2 or Primary Power Hub PNH-2P
- SoftdB Sound Masking Controller RL96-8ch
- Biamp Cambridge Qt X 800

2.3 LOUDSPEAKER ASSEMBLY

A. Loudspeaker enclosure shall provide upward facing coverage. Enclosure shall be a sealed, damped, circular enclosure suspended using chain at least 18 inches in length.

B. Enclosure shall be white and shall weigh no more than 5 lbs.

C. Loudspeaker shall be 4- to 5.25-inch diameter, capable of handling at least 10W rms, frequency response of 100 Hz to 10 kHz, and sensitivity of at least 86 dB(A) at 1 meter for 1 watt input.

D. Representative Quality: LogiSon LA-1

SoftdB SMS-STR

Biamp Cambridge DS1357W

PART 3 – EXECUTION

3.1 PRIOR TO INSTALLATION

A. The Contractor shall prepare diagrams indicating the proposed connections of all equipment to be furnished and equipment layout. These drawings, accompanied by component cuts and an itemization of quantities, must be submitted and approved before the Contractor commences fabrication or installation.

3.2 SEQUENCE OF INSTALLATION

A. The Contractor shall carefully coordinate the timing of installation of wiring.

3.3 LOUDSPEAKER

A. The success and performance of the masking sound systems is highly dependent on the quality of the loudspeaker installation and wiring. Loudspeakers shall be installed facing upwards as shown on Drawing SM-101.

3.4 CONTROL PANELS AND POWER SUPPLIES

A. The central controller and any needed power supplies shall be provided with one parallel quad receptacle fed by a 20 amp 110V AC circuit wired back to a dedicated breaker. There shall be no other switches in the line.

3.5 LABELING

A. The Contractor shall permanently label the face of the control panels indicating that the system was “Designed and Tuned by Ostergaard Acoustical Associates, 1460 US Highway 9 North, Woodbridge, NJ 07950, 973-731-7002, www.acousticalconsultant.com.

3.6 MANUALS AND AS-BUILT DRAWINGS

A. The Contractor shall provide as-built masking sound system drawings to the Owner and Acoustical Consultant.

B. The Contractor shall provide operation and service manuals for all installed equipment to the Owner.

C. Copies of as-built drawings as well as operation and service manuals shall be stored in a location near the masking sound system control panel.

3.7 TESTING PRIOR TO THE ARRIVAL OF THE ACOUSTICAL CONSULTANT

A. The Contractor shall inspect and test the entire sound system. The system check out shall include verifying the proper operation of all electronic components and loudspeakers, and the verification of correct connections of all circuits.

3.8 WARM-UP AND INITIAL ADJUSTMENT

A. The completed system shall be operated continuously, with gain set for 48 dB(A) masking level in areas served for a minimum of forty-eight (48) hours prior to the scheduled arrival of the Acoustical Consultant. The preliminary masking spectrum shall be set to achieve spectrum matching that recommended by the National Research Council Canada.

3.9 NOTIFICATION

A. The Contractor is responsible for verifying the scheduled move-in date and any modification to that date. The Contractor shall notify the Owner and the Acoustical Consultant, Ostergaard Acoustical Associates, of the system completion date a minimum of two weeks prior to the move-in date. The system shall be operational, tested, and warmed-up, for a minimum of one week prior to the earliest move-in date.

3.10 CONTROL PANEL CABINET KEYS

A. Supply Owner with two keys for each control panel enclosure and the Acoustical Consultant with a total of one key for each.

3.11 TUNING BY THE ACOUSTICAL CONSULTANT

A. The Contractor shall have a qualified technician familiar with the system and its installation present and available to assist the Acoustical Consultant during the testing and tuning of the system. This work may take place after normal working hours. Modify programmed gain of individual loudspeakers and equalization at the direction of the Acoustical Consultant.

3.12 WARRANTY

A. The Contractor shall provide written warranty for a period of one year from the date of acceptance covering all equipment and installation.

END OF SECTION 27 51 19

SECTION 28 46 00 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fire alarm system and associated components, including control units, related equipment, initiating devices, and notification appliances.

B. Installation of new UL listed speaker/strobe appliances

C. Installation of new UL listed smoke and heat detectors

D. New Edwards EST4 fire alarm control panel at the basement location indicated on Drawing E-704, replacing the existing EST-3 panel, with connections to new and existing-to-remain devices.

E. Installation of new NAC power supply and voice amplification panels as needed to support NICET calcuations

F. All NFPA 72 programming and testing

1.2 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

C. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices; 2022.

D. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

F. NECA 305 - Standard for Fire Alarm System Job Practices; 2018.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

J. UL 38 - Standard for Manual Signaling Boxes for Fire Alarm Systems; Current Edition, Including All Revisions.

K. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.

L. UL 268A - Standard for Smoke Detectors for Duct Application; Current Edition, Including All Revisions.

M. UL 521 - Standard for Heat Detectors for Fire Protective Signaling Systems; Current Edition, Including All Revisions.

N. UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.

O. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

P. UL 1480 - Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.

Q. UL 1971 - Standard for Signaling Devices for the Hearing Impaired; Current Edition, Including All Revisions.

R. UL 2075 - Standard for Gas and Vapor Detectors and Sensors; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. Evidence of designer qualifications:

1. Contractor shall work with the existing fire alarm vendor on Campus and coordinate all work.

2. Vendor:

a. Everon Solutions (sole-source campus vendor)

3. Vendor shall be required to complete the design and submit all design documents listed below

B. Comply with NFPA 72 chapter "Documentation," including noting names of installers, owners, and system classification information.

C. Design Documents: Submit all information required for plan review and permitting by AHJ, including floor plans, riser diagrams, and description of operation.

1. Copy (if any) of list of data required by AHJ.

2. NFPA 72 "Record of Completion", filled out to extent known at time.

3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A, and complete listing of software required.

4. Manufacturer's detailed product data sheet for each component, including wiring diagrams, and circuit length limitations. Catalog pages and product descriptions include ratings, dimensions, finishes, service conditions, and included features.

5. Certification by manufacturer of FACU that system design complies with Contract Documents.

6. Certification by Contractor that system design complies with Contract Documents.

D. Shop Drawings: Submit installation documentation required for plan review and permitting by AHJ, including floor plans showing locations of fire alarm system components, enlarged drawn to identified scale plan view, and riser diagrams.

1. System zone boundaries and interfaces to fire safety systems.

2. Show locations of components, circuits, and raceways; mark components with identifiers used in control unit programming.

3. Include elevations and details of proposed equipment arrangements.

4. Include system interconnection schematic riser diagram showing proposed and approved cable size and type; coordinated with floor plans and describing circuit class, survivability, and application specific information required by NFPA 72.

5. Include typical wiring diagrams for devices, notification appliances, remote indicators, annunciators, remote test stations, and EoL and power supervisory devices.

6. Include requirements and control diagrams for interfacing with other systems.

7. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; standby and spare capacity calculations; notification appliance circuit loop resistance and voltage drop calculations, including spare capacity.

8. List of devices and notification appliances on each SLC, with spare capacity indicated.

9. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.

10. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.

11. Detailed drawing of graphic annunciators, displays, and interfaces.

12. Certification by either FACU manufacturer or manufacturer of related equipment.

13. Certification by FACU manufacturer that system design complies with Contract Documents.

14. Certification by Contractor that system design complies with Contract Documents.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Inspection and Test Reports:

1. Submit inspection and test plan prior to closeout demonstration.

2. Submit documentation of satisfactory inspections and tests.

3. Submit NFPA 72 "Inspection and Test," filled out.

G. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:

1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.

2. Complete set of specified design documents, as approved by AHJ.

3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.

4. Contact information for firm that will be providing contract maintenance and trouble call-back service.

5. List of recommended spare parts, tools, and instruments for testing.

6. Replacement parts list with current prices, and source of supply.

7. Detailed troubleshooting guide and large scale input/output matrix.

8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to SUNY.

9. Detailed but easy to read explanation of procedures require recording of system trouble events by qualified personnel, such as when routine testing is being conducted for fire drills and when entering into contracts for building renovations.

H. Project Record Documents: Have one set available during closeout demonstration:

1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.

2. "As installed" wiring and schematic diagrams, with final terminal identifications.

I. Closeout Documents:

1. Certification by manufacturer that system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.

2. NFPA 72 "Record of Completion," filled out completely and signed by installer and authorized representative of AHJ.

3. Certificate of Occupancy.

1.4 QUALITY ASSURANCE

A. Copies of Design Criteria Documents: For duration of project, maintain at project site copy of each referenced document that prescribes execution requirements; bound together. Also, NFPA 72, relevant portions of other applicable codes, and instructions and guidelines of AHJ. Include in submittals upon completion.

B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer.

C. Installer Qualifications: Electrical Contractor with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.

1. Supervisor: Level III (three) or Level IV (four) certified fire alarm technician; furnish name and address.

2. Certified in the State in which the Project is located as fire alarm installer.

D. Manufacturer Qualifications: Company specialized in manufacturing products specified in this section with at least three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Division 01 construction waste management requirements for packaging waste requirements.

B. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 305.

C. Handle carefully to avoid damage to internal components, enclosure, and finish.

D. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.6 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Do not exceed maximum ambient temperature requirements for batteries at any time, which reduces battery service life. Replace batteries exposed to temperatures in excess of manufacturer's requirements.

C. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

D. Existing Conditions:

1. Modifications to Existing System:

a. Remove inactive or abandoned cables and components from existing fire alarm system.

b. Remove unused existing components and materials from site and dispose according to local and federal requirements.

c. Remove accessible portion of abandoned cables unless tagged with identification product suitable to withstand based on installed environment.

1.7 WARRANTY

A. See Division 01 closeout requirements for additional warranty requirements.

B. Fire Alarm Control Units and Accessory Equipment: Provide minimum 3-year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

C. Fire Alarm Manual Pull Stations: Provide minimum 1-year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

D. Fire Alarm System Detectors: Provide minimum 1-year year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

E. Fire Alarm System Notification Appliances: Provide minimum 1-year year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 FIRE ALARM SYSTEM

A. General Requirements:

1. Provide new fire alarm system complying with NFPA 70, NFPA 72, NFPA 90A, and consisting of required equipment, conduit, cabinets, outlet boxes, wiring, connectors, hardware, supports, accessories, components, software, and system programming as necessary for complete operating system that provides functional intent indicated.

2. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:

a. 36 CFR 1191 and ADA Standards.

b. Requirements of AHJ.

c. Applicable local codes.

d. Contract Documents.

e. NFPA 72; "should" is mandatory; where conflicts between requirements require deviation, identify deviations clearly on design documents.

3. Fire Alarm System Products:

a. Listed, classified, and labeled as suitable for purpose intended.

b. Installation Environments: Provide products suitable for their respective indoor and outdoor applications.

4. Provide fire alarm circuits in accordance with NFPA 70.

a. Comply with methods of interconnecting FACUs in accordance with NFPA 72 and NFPA 70.

b. Power Sources:

1) Comply with requirements for power supplies of emergency systems in accordance with NFPA 70.

2) Primary: Dedicated branch circuits from facility power distribution system.

3) Secondary: Storage batteries with capacity to operate system for period specified by NFPA 72.

c. Wiring and Wiring Methods:

1) General Requirements:

(a) Comply with requirements for wiring and wiring methods in accordance with NFPA 70.

(b) Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum-rated, listed and labeled as suitable for use in return air plenums.

(c) Special Occupancies: Comply with NFPA 70.

(d) Comply with NFPA 70 for wire and cable plenum, riser, general-purpose, limited-use, undercarpet, and underground applications.

2) Fire Alarm Circuits:

(a) Comply with NFPA 70 for conditions and types required for multiconductor cable systems.

(b) Non-Power-Limited Fire Alarm (NPLFA) Circuits:

(1) Provide dedicated NPLFA non-GFCI branch circuits for fire alarm equipment and marked by red identification in accordance with NFPA 70.

(c) Power-Limited Fire Alarm (PLFA) Circuits:

(1) Provide identification for PLFA circuits in accordance with NFPA 70.

5. Provide pathway class designations and pathway survivability, as defined in NFPA 72.

a. Provide monitoring of conductors and other signaling channels for integrity and circuit performance.

b. Pathway Class Designations:

1) Unless otherwise indicated or required, pathways to meet the following requirements:

(a) SLCs: Class B (star, tee-tap, multi-tap, with no return).

(b) IDCs: Class B (daisy-chain with EoL resistor device installed at end of circuit).

(c) NACs: Class B (daisy-chain with EoL resistor device installed at end of circuit).

c. Pathway Survivability:

1) Unless otherwise indicated or required, pathways to meet requirements for Pathway Survivability Level 1 (nonrated cable installed in metal raceway, building protected by automatic sprinkler system).

2) Evacuation Strategy: Total (general) evacuation with voice evacuation messages as indicated on Drawing E-704; partial evacuation and relocation are not used.

6. Spare System Capacity:

a. SLCs: Minimum 25 percent spare capacity.

b. NACs: Minimum 25 percent spare capacity.

7. Secondary Power Source - Battery Storage Capacity:

a. Provide standby (nonalarm) operation sufficient for 24 hours.

b. Provide additional alarm operation for 15 minutes.

c. Calculate combined of standby load plus alarm load for overall battery storage capacity requirements, per power supply.

d. Provide 25 percent additional overall battery capacity correction factor.

B. Fire Alarm System Interfaces and Control Functions:

1. UL 864 listed unless otherwise indicated.

2. Descriptions below are intended to provide means for interface. See project SOOs, narrative, and input/output matrix for execution requirements.

3. Provide initiating devices, interfaces, and control functions for emergency control function interfaces in accordance with NFPA 72.

4. Provide monitoring of interconnected systems. Coordinate notification appliance alternate markings as indicated on drawings.

5. Elevators:

a. Comply with ASME A17.1.

b. Elevator Shutoff:

1) Elevator Hoistway Heat Detector (machine-room-less elevators):

(a) Shut down elevator power prior to hoistway sprinkler activation.

(b) Locate within 24 inches of each sprinkler in accordance with NFPA 72.

2) Sprinkler Pressure or Waterflow: Shut down elevator power prior to hoistway sprinkler activation.

3) For each elevator, provide output signal to stop elevator via addressable relay module and power isolation relay.

c. Elevator Emergency Recall Operation:

1) Elevator Lobby, Hoistway, and Elevator Control Room or Space Smoke Detectors: Elevator recall for fire fighters' service.

2) At each elevator controller, provide interface for each elevator car or group of elevator cars as determined by AHJ via separate addressable relay modules for each output signal below, where applicable.

(a) Recall elevator to designated (primary) level.

(b) Recall elevator to alternate level.

(c) Smoke detection in elevator machine room (fire fighter's hat light).

6. Sound and Audio/Visual Media Control Systems:

a. System Override:

1) Provide output signal to override sound and audio/visual media controls via addressable relay module and power isolation relays.

2) Provide connection to UL 864 listed system interface or interface with system control power where interruption of control power overrides system.

7. Other Interconnected Systems: For systems listed below, provide minimum of two monitoring point inputs each.

a. Gas Detection Systems: Including providing notification appliances as indicated on plans for CO - Carbon Monoxide.

8. HVAC Systems:

a. Air Handling Units (AHUs) and Roof Top Units (RTUs):

1) Provide duct smoke detection as illustrated on the Drawings.

2) Provide remote test station for each duct smoke detector unless explicitly indicated as not required.

3) Provide output signal to shut down units with at least one duct smoke detector via addressable relay module.

4) Where fire/smoke dampers are located downstream of unit, provide monitoring point input to determine that unit is not operational and subsequently provide output signal to close such dampers via addressable relay module and power isolation relay.

b. Energy Recovery Units (ERUs):

1) Provide duct smoke detection as illustrated on the Drawings.

2) Provide remote test station for each duct smoke detector unless explicitly indicated as not required.

3) Provide output signal to shut down units with at least one duct smoke detector via addressable relay module.

4) Where fire/smoke dampers are located downstream of unit, provide monitoring point input to determine that unit is not operational and subsequently provide output signal to close such dampers via addressable relay module and power isolation relay.

9. Fire/Smoke Dampers:

a. Provide output signal to close fire/smoke damper via addressable relay module and power isolation relay.

10. Post-Fire Smoke Removal:

a. Nondedicated System:

1) Exhaust Fans, Supply Fans, and Energy Recovery Units (ERUs): Interface with BAS.

2) Fire/Smoke Dampers Also Used for Post-Fire Smoke Removal: Interface with fire alarm system as indicated under "Fire/Smoke Dampers" above, but also provide monitoring point to confirm open status of damper.

3) Interface with FACU utilizing modules, listed for smoke control use, as required for lamp outputs.

4) Control by BAS:

(a) Provide the following output signals and monitoring point inputs at FACU for interface with BAS:

(1) One relay output for building general alarm condition.

2.2 FIRE ALARM CONTROL UNITS AND RELATED EQUIPMENT

A. Manufacturers:

1. Edwards EST4.

2. Substitutions: Not permitted.

B. Fire Alarm Control Units and Related Equipment: Listed and labeled as complying with UL 864.

C. Provide cabinets and enclosures as indicated or as required to house system components.

D. Fire Alarm Control Unit (FACU): Addressable.

1. SLCs and IDCs: Configurable for Class B or Class A with additional modules.

2. NACs: Integral and programmable with synchronization modules or cards as required.

3. Power Supply: 120 VAC, 60 Hz, supplying necessary power for FACU.

4. User-Interface: Touchscreen display for system interfacing and service mode settings, include password and user credentials; configurable for custom actions and incorporates historical event log.

5. Support self-testing detector capability.

E. Addressable Interface Modules:

1. General Requirements:

a. Provide addressable modules suitable for connection to FACU SLCs.

b. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.

2. Addressable Monitor Modules: Unless devices are explicitly permitted connected together on one zone; provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable FACU.

3. Addressable Control Modules: Provide as indicated or as required for selective control of notification appliances.

4. Addressable Releasing Control Modules: Provide as indicated or as required for control of listed solenoids in releasing applications.

5. Addressable Relay Modules:

a. Provide as indicated or as required to perform necessary functions via dry-contact interface.

b. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.

6. Addressable SLC Isolating Modules:

a. Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally.

b. Provide automatic reset upon correction of short circuit.

F. Remote Annunciators:

1. LCD Remote Annunciators:

a. Provide backlit LCD display that mimics FACU display.

b. Provide dedicated status indications for power and alarm, supervisory, and trouble conditions.

c. Enable system control functions including acknowledge, silence, and reset.

d. Provide local audible alarm.

e. Mounting: Wall-mounted; provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.

2.3 FIRE ALARM SYSTEM INITIATING DEVICES

A. General Requirements:

1. Addressable Systems:

a. Addressable Devices: Individually identifiable by addressable FACU; suitable for connection to FACU SLCs.

b. Conventional/Nonaddressable Devices: Provide addressable interface modules as indicated or as required for connection to addressable FACU. Unless devices are explicitly permitted to be connected together as one zone, provide separate addressable monitoring point for each device in order to be individually identifiable by addressable FACU.

2. Provide devices and associated accessories suitable for intended application and location to be installed. Unless otherwise indicated, use addressable devices and addressable interface modules only in clean, dry, indoor, nonhazardous locations.

3. Surface-Mounted Devices: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.

4. Devices for Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes or enclosures in accordance with product listing.

B. Manual Fire Alarm Boxes/Pull Stations:

1. Description: Noncoded manual signaling boxes listed and labeled as complying with UL 38.

2. Alarm Initiation: Configured for general alarm initiation unless otherwise indicated; presignal stations (where indicated) require use of key to initiate general alarm.

3. Operation: Dual-action unless otherwise indicated or required.

a. Dual-Action Operation: First requires pushing, pulling, or lifting, then pulling of lever.

4. Color: Red, in accordance with NFPA 72.

5. Station Reset: Requires use of key or tool.

C. Spot-Type Detectors:

1. Utilize plug-in mounting to separate base with tamper-resistant feature; provide bases as indicated or as required.

2. Addressable Detectors:

a. Provide LED indication of normal operation and regular communication with FACU and alarm condition.

3. Smoke Detectors:

a. Listed and labeled as complying with UL 268.

b. Provide sensor type (e.g., photoelectric, ionization) as indicated.

4. Thermal/Heat Detectors:

a. Listed and labeled as complying with UL 521.

b. Provide sensor type (e.g., fixed temperature, rate-of-rise) and rating as indicated.

5. Carbon Monoxide Detectors:

a. Listed and labeled as complying with UL 2075.

b. Provide end-of-life notification.

D. Duct Smoke Detectors:

1. Listed and labeled as complying with UL 268A.
2. Ratings: Compatible with air velocity, temperature, and humidity requirements for installed duct.
3. Housing: Select as required for application.
4. Sampling Tubes: Select as required for installation in duct to be monitored.

2.4 FIRE ALARM SYSTEM NOTIFICATION APPLIANCES

A. General Requirements:

1. Provide signaling notification appliances listed for fire-protective service and intended operating mode, public or private; suitable for connection to FACU notification appliance circuits.
2. Provide notification appliances and associated accessories suitable for intended application and location to be installed. Use notification appliances only according to listed mounting (e.g. ceiling, wall).
3. Surface-Mounted Notification Appliances: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.
4. Exterior Notification:
    a. In addition to required occupant notification, provide notification appliances on exterior of building.
    b. Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes or enclosures in accordance with product listing.
    c. Visible Notification: Provide strobe beacon with red lens; interface to dedicated NAC or addressable control module, 24 VDC, supervised.
    d. Sprinkler System Waterflow Audible Notification: Provide bell; interface to dedicated NAC or addressable control module, 24 VDC, supervised; same circuit as sprinkler system waterflow visible notification where provided.
5. Notification Appliance Derating: Include device derating adjustments in accordance with listing where applicable, including the following.
    a. Where accessory protective guards or enclosures are utilized.
    b. Where required by field conditions (e.g., ambient temperature and sound).

B. Visible Notification Appliances:

1. Public Mode Operation: Listed and labeled as complying with UL 1971.

2. Strobes: Clear or nominal white lens with flash rate of 1 Hz unless otherwise indicated or required; xenon or LED light source with maximum pulse duration of 0.02 seconds; candela rating as indicated.

C. Speakers for ECS:

1. Listed and labeled as complying with UL 1480.

2. Rated Sound Pressure Level: As required to achieve design sound pressure levels, but not less than 75 dBA at 10 feet in accordance with UL 1480.

3. Frequency Range: 400 to 4,000 Hz minimum in accordance with UL 1480; listed for producing 520 Hz low frequency alarm signal for sleeping areas in accordance with NFPA 72.

4. Speaker Voltage: Field configurable, matched to audio distribution circuit voltage.

5. Provide minimum of four field-selectable power taps.

D. Combination Notification Appliances: Comply with respective requirements for each signaling method.

2.5 WIRE AND CABLE

A. General Requirements:

1. Comply with NFPA 70 listing and marking requirements for cables.

2. Substitution of fire alarm listed cables for communication wiring, in accordance with NFPA 70, is not permitted.

3. Provide cables as indicated or as required for connections between system components.

B. Power-Limited Fire Alarm Cables (PLFA):

1. Comply with applications of listed cables in accordance with Chapter 7 of NFPA 70.

a. Fire alarm cable substitutions in accordance with NFPA 70: Permitted.

C. Non-Power-Limited Fire Alarm Cables (NPLFA):

1. Comply with NPLFA circuit conductor properties in accordance with NFPA 72.

2. Comply with listing requirements in Chapter 7 of NFPA 70.

2.6 ACCESSORIES

A. Provide components as indicated or as required for connection of fire alarm system to devices and other systems indicated.

B. Provide EoL resistors as required for wiring supervision.

C. Documentation Cabinets:

1. Provide cabinets, size as indicated or as required to comply with on-site documentation storage required by NFPA 72.

2. Cabinet: Steel with red finish; keyed to match fire alarm system equipment unless otherwise required by AHJ.

D. Surge Protection:

1. Line Voltage Surge Protection:

a. Provide for each line voltage circuit serving fire alarm system control units and related equipment (e.g., FACU, field booster panels, nodes, and transponders).

b. Listed and labeled as complying with UL 1449.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that mounting surfaces are ready to accept components and equipment, with suitable support frames and anchors installed where required.

B. Verify ratings, configurations, and characteristics of system components.

C. Verify rough-ins for field connections.

D. Verify that work likely to damage fire alarm system has been completed.

E. Verify that interior of building has been protected from weather.

F. Perform preinstallation tests and inspections per manufacturer's instructions and in accordance with NECA 305.

G. Verify that system bonding is in accordance with Section 26 05 26.

H. Do not energize system until deficiencies have been corrected.

I. Verify that branch circuit wiring installation is completed, tested, and ready for connection to fire alarm system. Overcurrent protection ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

3.2 PREPARATION

A. Prior to installation, confirm environment of installation area is clean, and with ambient temperature, humidity, and ventilation requirements are per manufacturer’s written instructions.

1. Clean and vacuum in accordance with manufacturer's written instructions. Confirm equipment ventilation holes are absent of obstructions and free for air flow.

2. Clean pathways thoroughly to remove foreign materials before installing conductors and cables.

3. Clean dirt, debris, plaster, and other foreign materials from equipment enclosures, cabinets, and outlet boxes.

4. Clean surfaces to receive adhesive products according to manufacturer's instructions.

B. Follow tool requirements for installation, including torquing adjustments, as listed in manufacturer documentation.

C. Remove detector dust covers prior to system energization.

3.3 INSTALLATION

A. Install field-devices, components, FACU and related equipment, and accessories in accordance with the following:

B. Field Locations:

1. Obtain SUNY's approval of locations of devices and notification appliances before installation.

2. Arrange equipment to provide minimum operational clearances and required maintenance access in accordance with manufacturer's instructions and NFPA 70.

3. Conceal wiring, conduit, outlet boxes, and supports where installed in finished areas; maintain code-required access.

C. Raceways and Supports:

1. Coordinate locations of outlet boxes as required for installation. Only install boxes and equipment at locations based on application standards indicated in NFPA 72.

2. Secure and support raceways at intervals complying with NFPA 70. Provide supports where vertical rise exceeds permissible limits.

3. Provide minimum of six spare 1-inch trade size conduits out of each fire alarm panel stubbed into accessible space above ceiling.

4. Install firestopping to preserve fire resistance rating of partitions and other elements.

D. Wiring and Connections:

1. Maintain separation of Class 1, Class 2, Class 3 remote-control, signaling, fire alarm circuits, and power-limited circuits in accordance with cable insulation class and NFPA 70.

2. Maintain circuit pathway and class designations in accordance with NFPA 72 for configuration, separation, and survivability.

3. Comply with permitted and not permitted installations for wires, cables, cable routing assemblies, communications circuits, and fire alarm circuits in accordance with NFPA 70.

4. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by AHJ. Provide independent support from building structure and suspended ceiling systems. Do not provide support from raceways, piping, ductwork, or other systems.

5. Provide grounding and bonding in accordance with Section 26 05 26.

6. Comply with manufacturer's minimum cable sizes or ratings.

7. Do not exceed manufacturer's recommended maximum power, signal, or network cable lengths between components.

8. Provide network wiring in accordance with NFPA 70.

9. Neatly train and bundle conductors inside boxes, wireways, and cabinets.

10. See manufacturer's instructions for batteries.

E. Fire Alarm System Components:

1. Install field-installed devices, components, relays, notification appliances, accessories, and when applicable EoL resistors.

   a. Install wiring to supervisory devices and associated EoL resistors as required for supervision of hardwired connections

2. Install Wall-Mounted Equipment: Assemble component hardware within (e.g., card bays, sub-bays, expansion bays, signal cards, other card frames, networking, signal transmission, application modules, tamper monitoring devices, interconnecting modules, and auxiliary power supplies), including space for required spare capacity, and configure settings.

3. Install Interconnect Wiring: Connect system cabinets, install processor and cards, cabling, connectors, terminations, and bonding.

F. Branch Power:

1. After installation confirmations, follow manufacturer instructions to connect branch circuit power cables to premises fire alarm system components; comply with NFPA 70.

2. Where accessories require auxiliary power, provide control power source and monitoring as indicated or as required to complete installation.

3. Install auxiliary power supplies, including indicated monitoring, and connections necessary for remote equipment.

G. System Identification:

1. Identify devices, notification appliances, components, cables, and equipment in accordance with approved submittals. See Section 26 05 53.

2. Confirm fire alarm system programming meets requirements of SOO and sub-system SOOs.

3. Mark location of disconnecting means for NPFLA circuits.

4. Coordinate to provide red branch power circuit protective devices or identify them accordingly as required by NFPA 72 and NFPA 70.

5. Mark date of batteries installed on inside cover of panels and formal maintenance logs.

H. Troubleshooting and Installer Checks:

1. Field test connectivity periodically during installation process to avoid unexpected troubleshooting.

2. Check system operation for notification, FACU functions, circuit supervision, alarm initiating devices, supervisory initiating devices, dress panels/doors/covers, and programming before performing field tests.

I. Fire Alarm System Tests:

1. Perform required tests of NFPA 72. Record measured values during operational checks.

2. Confirm functional testing of fire alarm system is as indicated in Contract Documents.

3.4 FIELD QUALITY CONTROL

A. See Division 01 quality requirements for additional requirements.

B. Provide services of manufacturer's authorized representation to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's detailed testing procedures and field reports and with submittals.

C. Provide equipment, two-way radios for testing personnel use, tools, and supplies required to accomplish inspection and testing.

D. Notify SUNY and Engineer at least two weeks prior to scheduled inspections and tests.

E. Inspect and test in accordance with manufacturer's instructions.

F. Inspect wiring and components for damage and defects.

G. Batteries and Power Supplies: Perform inspections and tests listed in manufacturer installation instructions.

H. Perform additional requirements related to testing and inspection during system startup.

I. Test for interface with other systems.

J. Test shunt trips to verify operation.

K. Correct defective work, adjust for operation, and retest until entire system complies with Contract Documents.

L. Submit detailed reports indicated inspection and testing results, corrective actions taken, and as-found and final adjusted settings.

3.5 SYSTEM STARTUP

A. Obtain SUNY approval prior to performing system startup.

B. Manufacturer Services: Provide services of manufacturer's authorized representation to systems startup. Include manufacturer's detailed startup procedures with submittals.

C. Prepare and start equipment and systems in accordance with manufacturer's instructions and recommendations.

3.6 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust initiating device and notification appliance settings to achieve desired operation as indicated in submittals.

C. Measure power supply primary and secondary voltages, log values for records, and make appropriate adjustments.

D. Adjust alignment of equipment covers and doors. Provide keys and spare keys to SUNY.

E. Reprint and reinstall damaged or misinstalled labels; maintain neat and square to installed location good workmanship - see NECA 1; maintain consistent placements for identification on products of similar type.

F. Adjust devices or notification appliances and associated bases to be flush and level.

G. Program system parameters according to requirements of SUNY.

3.7 CLEANING

A. See Division 01 execution and closeout requirements for additional requirements.

B. See Division 01 construction waste management requirements for field-generated construction waste requirements.

C. Check tightness of electrical connections. Replace damaged components and provide closure plates for vacant positions. Provide circuit directory updates for related power branch circuits.

D. Clean and repair existing materials and equipment that remain or are indicated for reuse.

E. Clean dirt, debris, plaster, and other foreign materials from outlet boxes and fire alarm system equipment and components.

F. Clean fire alarm system equipment and components according to manufacturer's instructions and NECA 305.

G. Clean surfaces and interiors of boxes and device cover plates in accordance with manufacturer's instructions to remove dirt, fingerprints, debris, plaster, and other foreign materials.

H. Repair scratched or marred exposed surfaces to match original factory finish.

I. Comply with federal (EPA), state, and local regulations for battery handling and disposal. Do not spill battery fluids down plumbing drains. Only use containers safe for transportation marked 'nonspillable.'

3.8 INSPECTION AND TESTING FOR COMPLETION

A. Notify SUNY 7 days prior to beginning completion inspections and tests.

B. Contractor shall be required to provide all programming and testing of the proprietary supervising station (head end).

C. Notify AHJ and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

D. Provide services of installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.

E. Prepare for testing by ensuring that work is complete and correct; perform preliminary tests as required.

F. Provide tools, software, and supplies required to accomplish inspection, testing, and document results.

G. Perform inspection and testing in accordance with NFPA 72 and requirements of AHJ; document each inspection and test.

H. Correct defective work, adjust for operation, and retest until entire system complies with Contract Documents.

I. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without system or equipment malfunctions.

1. Record system operations and malfunctions.

2. If malfunction occurs, start diagnostic period over after correction of malfunction.

3. SUNY will provide attendant operator personnel during diagnostic period; schedule training to allow SUNY personnel to perform normal duties.

4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.9 CLOSEOUT ACTIVITIES

A. See Division 01 closeout requirements for additional submittals.

B. See Division 01 demonstration and training requirements for additional requirements.

C. Closeout Demonstration: Demonstrate operation of all functions to SUNY.

1. Be prepared to conduct any of required tests.

2. Have minimum one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.

3. Have authorized technical representative of FACU manufacturer present during demonstration.

4. Demonstration may be combined with inspection and testing required by AHJ; notify AHJ with enough time to schedule demonstration.

5. Repeat demonstration until successful.

D. Occupancy will not occur prior to Substantial Completion.

E. Substantial Completion of project cannot be achieved until inspection and testing is successful and the following:

1. Specified diagnostic period without malfunction has been completed.

2. Approved operating and maintenance data has been delivered.

3. All aspects of operation have been demonstrated to SUNY.

4. Final acceptance of fire alarm system has been given by AHJ.

5. Occupancy permit has been granted.

3.10 PROTECTION

A. Protect installed fire alarm system from subsequent construction operations.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and removing/abandoning site utilities.
8. Temporary erosion and sedimentation control.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 MATERIAL OWNERSHIP

A. Except for 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.

1.5 INFORMATIONAL 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 video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Burning is not permitted.

1.1 ACTION SUBMITTALS

A. Product Data: For each product type.

1.2 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.3 FIELD 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 trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as directed by Architect.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

G. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

H. Do not direct vehicle or equipment exhaust toward protection zones.

I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

J. Take precautions to protect plants from airborne contaminants, such as paint or fireproofing overspray.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer).

C. Organic Mulch, Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
1. Type: Shredded hardwood.
2. Size Range: 2 inches maximum, ½ minimum.
3. Color: Natural.

D. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements:

1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible from minus 60 to plus 200 deg F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 96 inches apart.

a. Height: 48 inches.
b. Color: High-visibility orange, nonfading.

2. Gates: Access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones.

E. Protection-Zone Signage: Shop-fabricated, rigid plastic sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As indicated on Drawings.
2. Lettering: 3-inch-high minimum, black characters on white background.

2.2 TEMPORARY EROSION AND SEDIMENT CONTROL MATERIALS

A. General: Comply with the requirements of New York State Standards and Specifications for Erosion and Sediment Control, latest edition.

B. Compost Filter Sock and Posts

1. Filter Sock: Filter Sock material shall meet the New York State Standards and Specification for Erosion and Sediment Control, latest edition.
2. Posts: Minimum 2 inches by 2 inches hardwood stakes.

C. Drop Inlet Protection

1. Drop Inlet Protection in Pavement
   a. Filter Sock: Refer to Section 2.2.B.
   b. Stone: Mix of No. 1 and No. 2 size crushed stone coarse aggregate meeting the requirements of NYSDOT Section 703-02. Slag is not permitted.

2. Manufactured Storm Grate Filtration
   a. The storm grate filtration inlet protection unit shall be a geotextile fabric unit.
   b. The storm grate filtration inlet protection unit shall have lifting straps to allow removal of the unit and manual inspection of the storm water system.
   c. The storm grate filtration inlet protection unit shall utilize an orange monofilament fabric with the following characteristics:

PROPERTY	TEST METHOD	UNITS	TEST RESULTS
Grab Tensile Strength	ASTM D 4632	lbs	450 x 300
Grab Tensile Elongation	ASTM D 4632	%	40 x 25
Puncture Strength	ASTM D 4833	lbs	130
Mullen Burst Strength	ASTM D 3786	psi	600
Trapezoidal Tear Strength	ASTM D 4533	lbs	165 x 150
% Open Area (POA)	COE – 22125-86	%	28
Apparent Opening Size	ASTM D 4751	US Std Sieve	30
Permittivity	ASTM D 4491	sec[1]	3.5
Permeability	ASTM 4491	cm / sec	.25
Water Flow Rate	ASTM 4491	gal/min/sf	250
Ultraviolet Resistance	ASTM D 4355	%	70
Color			Orange

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

1. Measures, materials, and their installation shall comply with the Erosion and Sediment Control Plan, specific to the site, and the requirements of the New York State Standards and Specifications f
2. or Erosion and Sediment Control, latest edition.

B. Install compost filter socks at all slope embankments, stockpiled materials, and where indicated. Place filter socks on the contour with both terminal ends of the sock extended 8 feet upslope at a 45 degree angle to prevent bypass flow, and to serve as a temporary slope breaker to reduce runoff velocity. Adequate area for sediment storage and maintenance of sediment containment area shall be provided.

C. Install drop inlet protection at all new and existing drop inlets / catch basins not scheduled for remova

D. l within the limits of construction. Drop inlet protection shall not be removed until landscaped and subgrade areas are permanently stabilized.

E. Where construction activities temporarily cease for a period of 14 days or more, immediately apply temporary seed and mulch to stabilize exposed earth. Areas of unprotected, erodible earth material exposed by clearing and grubbing, excavation, borrow or fill shall not be left in an unprotected condition.

1. Temporary seeding shall consist of “quick grow” rye grass mixture. Should temporary seeding operations occur during October or November, temporary seeding shall consist of “Aroostook” w
2. inter ryegrass.

F. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

G. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

H. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 2-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.

3.4 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remai

2. n, provide appropriate means of post support acceptable to Engineer.
3. Plastic Fencing: Stretch fabric taut and secure to posts without bows or sags.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 35 ft. on protection-zone fencing, but no fewer than two signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain hydration of plants to assure plant survival.

E. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Small Trees: Provide new trees of same size and species as those being replaced for each tree that measures 6 inches or smaller in caliper size.
2. Large Trees: Provide two new tree(s) of 3-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.

    a. Species: As selected by Landscape Architect and Owner.

3. Plant and maintain new trees as specified in Section 329300 "Plants."

3.6 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 or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

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 two weeks in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections.

3.7 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. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade 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.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.8 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
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.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.9 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 36 inches.
2. Do not stockpile rock within protection zones.
3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the Owner.

3.10 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.11 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.

B. Burning tree, shrub, and other vegetation waste is not permitted.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00

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SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Subbase course for concrete walks.
5. Subbase course for asphalt paving.
6. Subsurface drainage fill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:
1. Section 31 10 00 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Section 32 92 00 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed 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.

B. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock:

1. 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 D1586.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference at Project site.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data: For each products type.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D1557.

C. Preexcavation 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.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

B. Comply with materials, workmanship, and all other applicable requirements of the New York State Department of Transportation (NYSDOT) for earthwork.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this section.

1.7 FIELD 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 utility locator service for area where Project is located before beginning earth-moving operations.

C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 31 10 00 "Site Clearing" are in place.

D. Do not commence earth-moving operations until plant-protection measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 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, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, 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.

D. Subbase Material: Naturally or artificially graded mixture of crushed stone, only, conforming to NYSDOT subbase course Type 2.

E. Structural Fill: Naturally or artificially graded mixture of crushed gravel, crushed stone, and natural or crushed sand, only, conforming to one of the following:

1. NYSDOT Subbase Course Type 1, slag is not permitted.
2. NYSDOT Subbase Course Type 2, slag is not permitted.
3. NYSDOT Subbase Course Type 4, slag is not permitted.

F. Embedment Material / Bedding Course: Naturally or artificially graded mixture of crushed gravel or crushed rock, only, conforming to the requirements of NYSDOT coarse aggregate size designation 1.

G. Drainage Fill: Naturally or artificially graded mixture of crushed gravel or crushed rock, only, conforming to the requirements of NYSDOT coarse aggregate size designation 1A.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

I. Sand: ASTM C33/C33M; fine aggregate.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: 157 lbf; ASTM D4632.
2) Sewn Seam Strength: 142 lbf; ASTM D4632.
3) Tear Strength: 56 lbf; ASTM D4533.
4) Puncture Strength: 56 lbf; ASTM D4833.

c. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
d. Permittivity: 0.2 per second, minimum; ASTM D4491.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent;

complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

    a. Class 2; AASHTO M 288.
    b. As follows:

        1) Grab Tensile Strength: 247 lbf; ASTM D4632.
        2) Sewn Seam Strength: 222 lbf; ASTM D4632.
        3) Tear Strength: 90 lbf; ASTM D4533.
        4) Puncture Strength: 90 lbf; ASTM D4833.

    c. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
    d. Permittivity: 0.02 per second, minimum; ASTM D4491.
    e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 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

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by 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.

3.2 DEWATERING

A. Provide 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.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. 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.

D. 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.

3.3 EXPLOSIVES

A. Explosives:

1. Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.

f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR 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. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and 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 or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, 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.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

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:

1. Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

    a. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate 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.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.8 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill 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 15 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.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, 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 Architect, without additional compensation.

3.9 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 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
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, 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.

3.12 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. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before

backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

    a. 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.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:
1. Retain "Soil Backfill" Subparagraph below if satisfactory soil material is required as final backfill.
    a. Under grassed (lawn) areas, backfill to subgrade with satisfactory excavated or borrow material compacted in 6- to 8-inch lifts.
    b. Under walks and pavements, backfill to subgrade with structural fill or subbase material.
    c. Under steps, backfill to subgrade with structural fill.
    d. Under building slabs, backfill to subgrade with structural fill.

H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

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, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 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.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 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 soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.16 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 away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

6. Compact subbase course and base 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 D1557.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.20 FIELD QUALITY CONTROL

A. Special Inspections: Owner will 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 classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. 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.

E. 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.

3.21 PROTECTION

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.

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.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

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SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.
5. Asphalt surface treatments.

B. Related Requirements:

1. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase courses, and aggregate pavement shoulders.
2. Section 32 13 13 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
3. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.3 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Joint sealant.

B. Submit an Environmental Product Declaration (EPD) from the manufacturer for each asphalt mix within this specification section, if available. A statement of the contractor's good faith effort to obtain the EPD shall be provided if not available.

1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

C. Hot-Mix Asphalt Designs:

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paving-mix manufacturer and testing agency.

B. Material Certificates: Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

1. Aggregates.
2. Asphalt binder.
3. Asphalt cement.
4. Cutback prime coat.
5. Emulsified asphalt prime coat.
6. Tack coat.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the New York State Department of Transportation.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the New York State Department of Transportation (NYSDOT) for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Asphalt Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: Sound; angular crushed stone, crushed gravel meeting the requirements of NYSDOT 703-02. Slag is not permitted.

C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone, gravel or combination thereof, meeting the requirements of NYSDOT 703-01. Slag is not permitted.

1. For hot-mix asphalt, limit natural sand to a maximum of 10 percent by weight of the total aggregate mass.

D. Mineral Filler: NYSDOT 703-08 rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: Binder designation PG 64-22, meeting NYSDOT 702-64S22.

B. Asphalt Cement: Meeting NYSDOT 702-0700.

C. Emulsified Asphalt Prime Coat: Emulsified asphalt, rapid setting, diluted in water, of suitable grade and consistency for application. Meeting NYSDOT 702-3102, grade HFRS-2.

D. Tack Coat: Emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application. Meeting NYSDOT 702-3601, grade SS-1h.

E. Water: potable.

2.3 AUXILIARY MATERIALS

A. Herbicide: Do not use herbicides.

B. Sand: ASTM D1073 or AASHTO M 29, Grade No. 2 or No. 3.

C. Joint Sealant: Single component, hot-applied, rubberized asphalt sealant conforming to ASTM D6690, Type II.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Shim Course: Truing & Leveling F9 Asphalt, 80 Series Compaction, NYSDOT Item No. 404.0189CF
3. Binder Course: 25 F9 Binder Course Asphalt, 80 Series Compaction, NYSDOT Item No. 402.2589CF.
4. Top Course: 9.5 F2 Top Course Asphalt, 80 Series Compaction, NYSDOT Item No. 402.0982CF.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment 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.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
7. Keep milled pavement surface free of loose material and dust.
8. Do not allow milled materials to accumulate on-site.

3.4 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement,

unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Two-Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.7 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt binder course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt binder course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with ASTM D6927, but not less than 94 percent or greater than 100 percent.
2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Binder Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Binder Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with ASTM D979/D979M.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site,

prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan.

B. Except for material indicated to be recycled, remove excavated materials from Project Site and legally dispose of them in EPA-approved landfill.

    1. Do not allow milled materials to accumulate on site.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving including the following:
   1. Walks and Exterior Pads.

B. Related Requirements:

   1. Section 03 30 00 "Cast-in-Place Concrete" for general building applications of concrete.
   2. Section 321316 “Decorative Concrete Paving” for colored concrete paving and finishes.
   3. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
   4. Section 32 17 26 "Tactile Warning Surfacing" for detectable warning tiles.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

   1. Exposed Aggregate: 10-lb Sample of each mix.

C. Submit an Environmental Product Declaration (EPD) from the manufacturer for each asphalt mix within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

   1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930

Core rules for environmental product declarations of construction products and services.

D. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F 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 design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.

C. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.

D. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.

E. Tie Bars: ASTM A615/A615M, Grade 60; deformed.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

H. Zinc Repair Material: ASTM A780/A780M.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Blended Hydraulic Cement: ASTM C595/C595M, Type IL, portland-pozzolan cement.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4-inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.

2. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

E. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, recycled rubber in preformed strips.

B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 15 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content, 3/4-inch Nominal Maximum Aggregate Size: 6 percent plus or minus 1-1/2 percent.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range, water-reducing admixture in concrete as required for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 5,000 psi.
2. Maximum W/C Ratio at Point of Placement: 0.40.

3. Slump Limit: 4 inches, plus or minus 1 inch.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete walks to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. 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.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges 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 paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters,and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. 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.

F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

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.

G. Screed paving surface with a straightedge and strike off.

H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

I. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and 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 planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. 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.

3.8 INSTALLATION OF DETECTABLE WARNINGS

A. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 32 17 26 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 32 17 26 "Tactile Warning Surfacing" immediately after screeding concrete surface.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. 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:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair

any holes or tears occurring during installation or 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.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results to be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 13 16 - DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Colored concrete paving.
   2. Stamped concrete paving.

B. Related Requirements:
   1. Section 32 13 13 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, and stamped detectable warnings.
   2. Section 32 13 73 "Concrete Paving Joint Sealant" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
      a. Concrete mixture design.
      b. Quality control of concrete materials and decorative concrete paving construction practices.
   2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Decorative concrete paving Installer.
      e. Manufacturer's representative of decorative concrete paving system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

C. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer, ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.
   4. Curing compounds.
   5. Applied finish materials.
   6. Bonding agent or epoxy adhesive.
   7. Joint fillers.

C. Material Test Reports: For each of the following:
   1. Aggregates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
   2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F 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 design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Refer to Section 32 13 13 "Concrete Paving".

2.4 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:
   1. Refer to Section 32 13 13 "Concrete Paving".

C. Normal-Weight Aggregates:
   1. Refer to Section 32 13 13 "Concrete Paving".

D. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
      a. Euclid Chemical.
      b. Soloman Colors.
      c. Sika Corporation.
      d. Butterfield Colors.
   2. Product/Manufacturer: Basis of Design.
      a. CHROMIX Admixtures for Color-Conditioned Concrete including CHROMIX P Admixtures, CHROMIX G Admixtures, or CHROMIX L Admixtures; Sika Corporation.
      b. Admixture shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are lime-proof and ultra-violet resistant.
      c. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494 and ASSHTO M194.
      d. Raw pigments are not an equivalent and may not be substituted.

2.5 SURFACE COLORING MATERIALS

A. Pigmented Powder Release Agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

2.6 STAMPING DEVICES

A. Stamp Mats: Semirigid polyurethane mats with projecting textured and ridged underside capable of imprinting texture and joint patterns on plastic concrete.

2.7 CURING AND SEALING MATERIALS

A. Manufacturers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
   a. Euclid Chemical.
   b. Sika Corporation.
   c. W.R. Meadows.
   d. Dayton Superior.

B. High-Solids, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, non-yellowing, manufactured for use with colored concrete.
   1. Curing compound shall be pigmented type matching color of integrally colored concrete and shall be approved by coloring admixture manufacturer.
   2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
   3. Product/Manufacturer: Basis of Design.
      a. Curing and Sealing Compound: SCOFIELD® Cureseal-W Semi-gloss and SCOFIELD Cureseal 700 Matte; Sika Corporation.

C. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.
   1. Product/Manufacturer: Basis of Design.
      a. Scofield Traction Additive; Sika Corporation.

2.8 RELATED MATERIALS
   1. Refer to Section 32 13 13 "Concrete Paving".

2.9 CONCRETE MIXTURES

A. For mix designs refer to Section 32 13 13 "Concrete Paving".

B. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.

C. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.10 COLORS

A. Concrete Colors:
   1. Cement: Color shall be gray.
   2. Sand: Color shall match Landscape Architect's sample.
   3. Aggregate: Concrete producer's standard aggregate complying with mix design requirements.
   4. Colored Admixture: As selected by Landscape Architect.

B. Curing Compound: Color to match integrally colored concrete.

2.11 CONCRETE MIXING

A. Slump of concrete shall be consistent throughout Project at 4-inches or less. At no time shall slump exceed 5-inches.

B. Do not add calcium chloride to mix as it causes mottling and surface discoloration.

C. Supplemental admixtures shall not be used unless approved by manufacturer.

D. Do not add water to the mix in the field.

E. Add colored admixture to concrete mix according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Section 32 13 13 "Concrete Paving".

3.2 PREPARATION

A. Refer to Section 32 13 13 "Concrete Paving".

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Refer to Section 32 13 13 "Concrete Paving".

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. Refer to Section 32 13 13 "Concrete Paving".

3.5 JOINTS

A. Refer to Section 32 13 13 "Concrete Paving".

3.6 CONCRETE PLACEMENT

A. Refer to Section 32 13 13 "Concrete Paving".

3.7 FLOAT FINISHING

A. Refer to Section 32 13 13 "Concrete Paving".

3.8 INTEGRALLY COLORED CONCRETE FINISH

A. Integrally Colored Concrete Finish: After final floating, apply the following finish:

1. 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.

3.9 PIGMENTED RELEASE AGENT

A. Pigmented Powder Release Agent: Uniformly distribute onto still-plastic concrete at a rate of 3 to 4 lb/100 sq. ft..

3.10 STAMPING

A. Mat Stamping: After floating and while concrete is plastic, apply mat-stamped finish.
   1. Liquid Release Agent: Apply liquid release agent to the concrete surface and the stamp mat. Uniformly mist surface of concrete at a rate of 5 gal/1000 sq. ft..
   2. After application of release agent, accurately align and place stamp mats in sequence.
   3. Uniformly load mats and press into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp mats. Hand stamp edges and surfaces unable to be imprinted by stamp mats.
   4. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.11 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Curing and Sealing 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. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.12 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
   1. Elevation: 3/4 inch.
   2. Thickness: Plus 3/8 inch, minus 1/4 inch.
   3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
   4. Lateral Alignment and Spacing of Dowels: 1 inch.
   5. Vertical Alignment of Dowels: 1/4 inch.
   6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
   7. Joint Spacing: 3 inches.

8. Contraction Joint Depth: Plus 1/4 inch, no minus.
9. Joint Width: Plus 1/8 inch, no minus.

3.13 FIELD QUALITY CONTROL

A. Refer to Section 32 13 13 "Concrete Paving".

3.14 REPAIR AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 16

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants for concrete pavement.
2. Hot-applied joint sealants for joints between concrete pavement and asphalt pavement.
3. Joint-sealant backer materials.
4. Primers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

C. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.

1. Size: 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.

D. Paving-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.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer and testing agency.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Performed by a qualified testing agency.

1.7 FIELD 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 deg F.
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

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer 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.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.

2.5 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.6 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

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.

3.3 INSTALLATION OF JOINT SEALANTS

A. 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 C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.
2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact 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.

E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. 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.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joints within concrete paving:

1. Joint Location:

    a. Expansion and isolation joints in concrete paving.
    b. Contraction joints in concrete paving.
    c. Other joints as indicated.

2. Joint Sealant: Single-component, self-leveling, silicone joint sealant.
3. Joint-Sealant Color: Manufacturer's standard.

B. Joints within concrete paving and between concrete and asphalt paving:

1. Joint Location:

    a. Joints between concrete and asphalt paving.
    b. Other joints as indicated.

2. Joint Sealant: Hot-applied, single-component joint sealant.
3. Joint-Sealant Color: Manufacturer's standard.

END OF SECTION 32 13 73

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SECTION 32 14 00 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stone pavers.
   2. Curbs and edge restraints.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. For materials other than water and aggregates.
   2. For the following:
      a. Pavers.
      b. Bituminous setting materials.
      c. Mortar and grout materials.
      d. Edge restraints.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

C. Samples for Initial Selection: For each type of unit paver indicated. and the following:
   1. Joint materials involving color selection.
   2. Exposed edge restraints involving color selection.
   3. Mortar and grout materials for color selection.

D. Samples for Verification: For full-size units of each type of unit paver indicated. Include Samples of the following:
   1. Joint materials.
   2. Exposed edge restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
   1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified unit paving installer. Installer's personnel assigned to the Work must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with both of the following designations:
   1. Residential Paver Technician Designation.
   2. Commercial Paver Technician Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.
   1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:
   1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
   2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
      a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 STONE PAVERS

A. Granite Pavers: Rectangular paving slabs made from granite complying with ASTM C615/C615M.
   1. Color and Grain: Woodbury Granite matching the existing site materials.
   2. Finish: Thermal.
   3. Thickness: Nominal sizes between 2.25” and 3.25”.
   4. Face Size: Nominal size of 2’ x3’.

2.3 CURBS AND EDGE RESTRAINTS

A. Job-Built Concrete Edge Restraints: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

2.4 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.

B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.5 MORTAR SETTING-BED MATERIALS

A. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.
   1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   2. Provide product that is approved by manufacturer for application thickness of 5/8 inch.

B. Water: Potable.

C. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062 inch in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

2.6 GROUT MATERIALS

A. High-Performance Cement Grout: ANSI A118.7, sanded.
   1. Polymer Type:
      a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

B. Grout Colors: As selected by Landscape Architect from manufacturer's full range.

C. Water: Potable.

2.7 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.

2.8 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

C. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

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

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. 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. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: [**Running bond**] [**Herringbone**] [**Basket weave**] [**Grid**] [**As indicated**] [**Match and continue existing unit paver joint pattern**].

F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
1. Provide joint filler at waterproofing that is turned up on vertical surfaces[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete**].

G. Tolerances:
1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
2. 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.

H. Expansion and Control Joints:
1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints[**unless otherwise**

indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete]. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 07 92 00 "Joint Sealants."

2. Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
   2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.
   3. Install job-built concrete edge restraints to comply with requirements in Section 03 30 00 "Cast-in-Place Concrete."
   4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
   5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

J. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
   1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.

H. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

I. Spaced Joint Widths: Provide 3/8-inch nominal joint width with variations not exceeding plus or minus 1/16 inch.

J. Grouted Joints: Grout paver joints complying with ANSI A108.10.

K. Grout joints as soon as possible after initial set of setting bed.
   1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
   3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

L. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. 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. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 32 14 00

SECTION 32 16 40 – GRANITE CURBS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Granite curbs and edge restraints .

B. Related Requirements:

1. Section 31 20 00 “Earth Moving” for excavation and backfill.
2. Section 32 13 13 "Concrete Paving" for concrete paving walks, and backing.
3. Section 32 13 73 "Concrete Paving Joint Sealant" for sealants at concrete pavement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

a. Granite curbs.
b. Dry Concrete Backing edge restraint.

B. Samples for Initial Selection: For each type of unit paver indicated and the following:

1. Joint materials involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For granite curb and dry concrete backing. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store granite curb on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.6 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade. Remove and replace granite curb and edge restraint work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each granite curb unit from a single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CURBS AND EDGE RESTRAINTS

A. Job-Built Concrete Edge Restraints (Dry Concrete Backing): Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

B. Granite Curbs: Granite curbing, with face battered 1 inch per foot, produced in random lengths not less than 36 inches from granite complying with ASTM C615/C615M.

1. Granite Color and Grain: Light gray with fine grain.
2. Top Width: 5 inches.
3. Face Height: 6 inches.
4. Total Height: 16 inches.
5. Top Finish: Sawed.
6. Face Finish: Split.

2.3 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with requirements in Section 31 20 00 "Earth Moving" for subbase material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive granite curb, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where granite curb is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

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

3.2 PREPARATION

A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

B. Remove mortar and concrete from existing curbs to be reused.

C. Proof-roll prepared subgrade according to requirements in Section 31 20 00 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for granite curb.

3.3 INSTALLATION, GENERAL

A. Do not use granite curb with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Provide edge restraints as indicated. Install edge restraints before placing granite curb.

C. Set curbs true to line and grade on foundation of one cubic foot of dry concrete for each linear foot of curb installed. Fill voids to completely support entire length of curb.

D. Butt joint curb sections together.

END OF SECTION 32 14 00

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SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Painted markings applied to asphalt paving.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to marking asphalt paving or concrete surfaces including, but not limited to, the following:

a. Asphalt-paving aging period before application of pavement markings.
b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.3 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties for each product.

B. Shop Drawings:

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the Standard Specifications of the New York State Department of Transportation (NYSDOT) for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45minutes.

1. Color: As indicated.

B. Glass Beads: Comply with NYSDOT Section 727-05.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal..

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 32 17 23

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SECTION 32 17 26 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning metal tiles.

B. Related Requirements:

1. Section 32 13 13 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

C. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only 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 substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

    a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set unit pavers within 1 minute of spreading setting-bed mortar.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Deterioration of finishes beyond normal weathering and wear.
    b. Separation or delamination of materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing, joint material, setting material, anchor, and fastener from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles with replaceable surface configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
a. ADA Solutions, LLC., (800) 372-0519, 323 Andover St Ste 3, Wilmington, MA 01887
b. Advantage Tactile Systems, (800) 679-4022, 241 Main St Ste 100, Buffalo, NY 14203
c. EJ., (800) 874-4100, 301 Spring Street, PO Box 439, East Jordan, MI 49727
d. Neenah Foundry Company, (920) 725-7000, 2121 Brooks Ave, Neenah, WI 54956

2. Material:

a. Stainless-Steel Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316L.

1) Finish and Color:

a) Manufacturer's standard powder coat, red brick.
b) Mill finish.

b. Cast Iron: Gray iron, ASTM A 48/A 48M, CL 35.

3. Shapes and Sizes:

    a. Rectangular panel, 24 inches by length indicated on the Drawings.

4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing, in manufacturer's standard pattern.
5. Mounting:

    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
    b. Permanently embedded detectable warning tile set into formed recess in concrete and adhered with mortar.
    c. Replaceable embedded detectable warning tile fastened to permanently installed anchors.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish Type 316 stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

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

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 32 13 13 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

B. Removable Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 32 13 13 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

3.4 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 32 17 26

SECTION 32 32 16 PRECAST MODULAR BLOCK – MSE RETAINING WALL

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes furnishing all materials and labor required for the design and construction of a precast concrete modular block (PMB) retaining wall with or without geosynthetic reinforcement. Precast modular block retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 pounds (450 kg) per unit and may utilize concrete-reinforcing steel.

B. Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for the construction of a precast modular block (PMB) retaining wall structure in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project site plans.

C. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 31, Division 32 and Division 33 also apply to this Section.

1.2 REFERENCES

A. Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document.

B. Definitions:
1. Precast Modular Block (PMB) Unit – machine-placed, "wet cast" concrete modular block retaining wall facing unit.
2. Geotextile – a geosynthetic fabric manufactured for use as a separation and filtration medium between dissimilar soil materials.
3. Geogrid – a geosynthetic material comprised of a regular network of tensile elements manufactured in a mesh-like configuration of consistent aperture openings. When connected to the PMB facing units and placed in horizontal layers in compacted fill, the geogrid prevents lateral deformation of the retaining wall face and provides effective tensile reinforcement to the contiguous reinforced fill material.
4. Drainage Aggregate – clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction

requirements immediately adjacent to and behind the precast modular block units.

5. Unit Core Fill – clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, the same material used for drainage aggregate as defined above.
6. Foundation Zone – soil zone immediately beneath the leveling pad and the reinforced zone.
7. Retained Zone – soil zone immediately behind the drainage aggregate and wall infill for wall sections designed as modular gravity structures. Alternatively, in the case of wall sections designed with geosynthetic soil reinforcement, the retained zone is the soil zone immediately behind the reinforced zone.
8. Reinforced Zone – structural fill zone within which successive horizontal layers of geogrid soil reinforcement have been placed to provide stability for the retaining wall face. The reinforced zone exists only for retaining wall sections that utilize geosynthetic soil reinforcement for stability.
9. Reinforced Fill – structural fill placed within the reinforced zone.
10. Leveling Pad – hard, flat surface upon which the bottom course of precast modular blocks is placed. The leveling pad may be constructed with crushed stone or cast-in-place concrete. A leveling pad is not a structural footing.
11. Wall Infill – the fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures.

C. Reference Standards
   1. Design
      a. AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014.
      b. Minimum Design Loads for Buildings and Other Structures – ASCE/SEI 7-10.
      c. International Building Code, 2018 Edition.
      d. FHWA-NHI-10-024 Volume I and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
      e. FHWA-NHI-10-025 Volume II and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
      f. National Concrete Masonry Association (NCMA) Design Manual for Segmental Retaining Walls (ASD), 3rd Edition

   2. Precast Modular Block Units
      a. ACI 201 – Guide to Durable Concrete
      b. ACI 318 – Building Code Requirements for Structural Concrete
      c. ASTM A615 – Steel Bars for Concrete Reinforcement
      d. ASTM A767 – Galvanized Steel Bars for Concrete Reinforcement
      e. ASTM A775 – Epoxy-Coated Steel Reinforcing Bars

f. ASTM C33 – Standard Specification for Concrete Aggregates
g. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
h. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
i. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
j. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
k. ASTM C150 – Standard Specification for Portland Cement
l. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
m. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
n. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.
o. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
p. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
q. ASTM C666 – Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing.
r. ASTM C845 - Standard Specification for Expansive Hydraulic Cement.
s. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
t. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars.
u. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.
v. ASTM C1157 - Standard Performance Specification for Hydraulic Cement.
w. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
x. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
y. ASTM C1611 – Standard Test Method for Slump Flow of Self-Consolidating Concrete.
z. ASTM C1776 – Standard Specification for Wet-Cast Precast Modular Retaining Wall Units.
aa. ASTM D6638 – Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks).
bb. ASTM D6916 – Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks).

3. Geosynthetics
   a. AASHTO M 288 – Geotextile Specification for Highway Applications.

b. ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics Diaphragm Bursting Strength Tester Method.
c. ASTM D4354 – Standard Practice for Sampling of Geosynthetics for Testing.
d. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles
e. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
f. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
g. ASTM D4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
h. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
i. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile.
j. ASTM D4759 – Standard Practice for Determining Specification Conformance of Geosynthetics.
k. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
l. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
m. ASTM D5262 – Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.
n. ASTM D5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
o. ASTM D5818 – Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics.
p. ASTM D6241 – Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
q. ASTM D6637 – Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
r. ASTM D6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.
s. ASTM D6992 – Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method.

4. Soils
   a. AASHTO M 145 – AASHTO Soil Classification System.
   b. AASHTO T 104 – Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.

c. AASHTO T 267 – Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition.
d. ASTM C33 – Standard Specification for Concrete Aggregates.
e. ASTM D448 – Standard Classification for Sizes of Aggregates for Road and Bridge Construction.
f. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (12,400 ft-lbf/ft (2,700 kN-m/m)).
g. ASTM D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base and Surface Courses.
h. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
i. ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. (56,000 ft-lbf/ft (2,700 kN-m/m)).
j. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
k. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
l. ASTM D3080 – Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.
m. ASTM D4254 – Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
n. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
o. ASTM D4767- Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils.
p. ASTM D4972 – Standard Test Method for pH of Soils.
q. ASTM D6913 – Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
r. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Aggregate by Nuclear Methods (Shallow Depth).
s. ASTM G51 – Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing.
t. ASTM G57 – Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.

5. Drainage Pipe
   a. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   b. ASTM F2648 – Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preconstruction Meeting. As directed by the Owner, the General Contractor shall schedule a preconstruction meeting at the project site prior to commencement of retaining wall construction. Participation in the preconstruction meeting shall be required of the General Contractor, Retaining Wall Design Engineer (RWDE), Retaining Wall Installation Contractor (RWIC), Grading Contractor, and Inspection Engineer. The General Contractor shall provide notification to all parties at least 10 calendar days prio to the meeting.

1. Preconstruction Meeting Agenda:
   a. The RWDE shall explain all aspects of the retaining wall construction drawings.
   b. The RWDE shall explain the required bearing capacity of soil below the retaining wall structure and the shear strength of in-situ soils assumed in the retaining wall design to the Inspection Engineer.
   c. The RWDE shall explain the required shear strength of fill soil in the reinforced, retained and foundation zones of the retaining wall to the Inspection Engineer.
   d. The RWDE shall explain any measures required for coordination of the installation of utilities or other obstructions in the reinforced or retained fill zones of the retaining wall.
   e. The RWIC shall explain all excavation needs, site access and material staging area requirements to the General Contractor and Grading Contractor.

1.4 SUBMITTALS

A. Product Data. At least 14 days prior to construction, the General Contractor shall submit the retaining wall product submittal package to the Owner's Representative for review and approval. The submittal package shall include technical specifications and product data from the manufacturer for the following:
   1. Precast Modular Block System brochure
   2. Precast Modular Block concrete test results specified in paragraph 2.01, subparagraph B of this section as follows:
      a. 28-day compressive strength
      b. Air content
      c. Slump or Slump Flow (as applicable)
   3. Drainage Pipe
   4. Geotextile
   5. Geosynthetic Soil Reinforcement (if required by the retaining wall design). The contractor shall provide certified manufacturer test reports for the geosynthetic soil reinforcement material in the manufactured roll width specified. The test report shall list the individual roll numbers for which the certified material properties are valid.

B. Installer Qualification Data. At least 14 days prior to construction, the General Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the RWIC, per paragraph 1.07, subparagraph A of this section.

C. Delegated Design Submittals - Retaining Wall Design Calculations and Construction Shop Drawings. At least 14 days prior to construction, the General Contractor shall furnish electronic versions construction shop drawings and the supporting structural calculations report to the Owner for review and approval. This submittal shall include the following:
   1. Signed, sealed and dated drawings and engineering calculations prepared in accordance with these specifications.
   2. Qualifications Statement by the RWDE summarizing their Experience.
   3. Certificate of Insurance of the RWDE as specified in paragraph 1.06, subparagraph B of this section.

1.5 CONSTRUCTION SHOP DRAWING PREPARATION

A. The RWDE shall coordinate the retaining wall construction shop drawing preparation with the project Civil Engineer, project Geotechnical Engineer and Owner's Representatives. The General Contractor shall furnish the RWDE the following project information required to prepare the construction shop drawings. This information shall include, but is not limited to, the following:
   1. Current versions of the site, grading, drainage, utility, erosion control, landscape, and irrigation plans;
   2. electronic CAD file of the civil site plans listed in (1);
   3. report of geotechnical investigation and all addenda and any supplemental reports;
   4. recommendations of the project Geotechnical Engineer regarding effective stress shear strength and total stress shear strength (when applicable) parameters for in-situ soils in the vicinity of the proposed retaining wall(s) and for any fill soil that may potentially be used as backfill in retained and/or foundation zones of the retaining wall.

C. Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local, State, or national design or building code requirements exceed these specifications, these requirements shall also be satisfied.

D. The RWDE shall note any exceptions to the requirements of this section by listing them at the bottom right corner of the first page of the construction shop drawings.

E. Approval or rejection of the exceptions taken by the Retaining Wall Design Engineer (RWDE) will be made in writing as directed by the Owner.

F. The RWDE shall determine the appropriate standard(s) to be utilized, and to which the precast modular block design shall be based upon, except as noted herein. Refer to Part 1.03, Paragraph C, Part 1.

G. In the event that a conflict is discovered between these specifications and a reasonable interpretation of the design specifications and methods referenced in paragraph F above, these specifications shall prevail. If a reasonable interpretation is not possible, the conflict shall be resolved per the requirements in paragraph 1.03, subparagraph A of this section.

H. Soil Shear Parameters. The RWDE shall prepare the construction shop drawings based upon soil shear strength parameters from the available project data and the recommendations of the project Geotechnical Engineer. If insufficient data exists to develop the retaining wall design, the RWDE shall communicate the specific deficiency of the project information or data to the Owner in writing.

I. Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.

J. Global Stability. Overall (global) stability shall be evaluated in accordance with the principals of limit equilibrium analysis as set forth in FHWA-NHI-10-024 Volume I and FHWA-NHI-10-025 Volume II GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, or other methods, as determined by the RWDE, as referenced in Section 1.06, Part F. The minimum factors of safety shall be as follows:

Normal Service (Static)	1.3
Seismic	1.1
Rapid Drawdown (if applicable)	1.2

Note: RWDE to select appropriate FOS

K. Seismic Stability. Seismic loading shall be evaluated in accordance with AASHTO Load and Resistance Factor Design (LRFD) methodology, or NCMA (ASD) methodology as determined by the RWDE as referenced in Section 1.06, Part F.

1.6 QUALITY ASSURANCE

A. RWIC Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the RWIC shall possess the following:
   1. Experience.
      a. Construction experience with a minimum of 3,000 square feet (280 square meters) of the proposed precast modular block retaining wall system.
      b. Construction of at least three (3) precast modular block (large block) retaining wall structures within the past three (3) years.
      c. Construction of at least 5,000 square feet (465 square meters) of precast modular block (large block) retaining walls within the past five (5) years.
   2. RWIC experience documentation for each qualifying project shall include:
      a. Project name and location
      b. Date (month and year) of construction completion

c. Contact information of Owner or General Contractor
d. Type (trade name) of precast modular block system used
e. Maximum height of the wall constructed
f. Face area of the wall constructed

3. In lieu of these specific requirements, the contractor may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall construction.

B. RWDE (RWDE) Qualifications and Statement of Experience. The RWDE shall submit a written statement affirming that he or she has the following minimum qualifications and experience.
1. The RWDE shall be licensed to practice in the jurisdiction of the project location.
2. The RWDE shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.
3. The RWDE shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project, that the design considers all the requirements listed in paragraph 1.06 and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.
4. The RWDE shall affirm in writing that he or she has designed a minimum of approximately 3,000 face square feet (280 face square meters) of modular block earth retaining walls within the previous five (5) years.
5. In lieu of these specific requirements, the engineer may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall design.

C. The Owner reserves the right to reject the services of any engineer, engineering firm, or contractor who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

1.7 QUALITY CONTROL

A. The Owner’s Representative shall review all submittals for materials, design, RWDE qualifications and the RWIC qualifications.

B. The General Contractor shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the General Contractor. Inspection shall be continuous throughout the construction of the retaining walls.

C. The Inspection Engineer shall perform the following duties:
1. Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification.

2. Verify that soil or aggregate fill placed and compacted in the reinforced, retained and foundation zones of the retaining wall conforms with paragraphs 2.04 and 2.05 of this section and exhibits the shear strength parameters specified by the RWDE.
3. Verify that the shear strength of the in-situ soil assumed by the RWDE is appropriate.
4. Inspect and document soil compaction in accordance with these specifications:
   a. Required dry unit weight
   b. Actual dry unit weight
   c. Allowable moisture content
   d. Actual moisture content
   e. Pass/fail assessment
   f. Test location – wall station number
   g. Test elevation
   h. Distance of test location behind the wall face
5. Verify that all excavated slopes in the vicinity of the retaining wall are bench-cut as required.
6. Notify the RWIC of any deficiencies in the retaining wall construction and provide the RWIC a reasonable opportunity to correct the deficiency.
7. Notify the General Contractor, Owner and RWDE of any construction deficiencies that have not been corrected in a timely manner.
8. Document all inspection results and provide reports to Owner, RWDE, and RWIC.
9. Test compacted density and moisture content of the retained backfill with the following frequency:
   a. At least once every 500 square feet (45 square meters) (in plan) per vertical lift, and
   b. At least once per every 18 inches (460 mm) of vertical wall construction.

D. The General Contractor’s engagement of the Inspection Engineer does not relieve the RWIC of responsibility to construct the proposed retaining wall in accordance with the approved construction shop drawings and these specifications.

E. The RWIC shall inspect the on-site grades and excavations prior to construction and notify the RWDE and General Contractor if on-site conditions differ from the elevations, assumptions, and grading conditions depicted in the retaining wall construction shop drawings.

1.8 DELIVERY, STORAGE AND HANDLING

A. The RWIC shall inspect the materials upon delivery to ensure that the proper type, grade and color of materials have been delivered.

B. The RWIC shall store and handle all materials in accordance with the manufacturer's recommendations as specified herein and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the work.

C. Geosynthetics
   1. All geosynthetic materials shall be handled in accordance with ASTM D4873. The materials should be stored off the ground and protected from precipitation, sunlight, dirt and physical damage.

D. Precast Modular Blocks
   1. Precast modular blocks shall be stored in an area with positive drainage away from the blocks. Be careful to protect the block from mud and excessive chipping and breakage. Precast modular blocks shall not be stacked more than three (3) units high in the storage area.

E. Drainage Aggregate and Backfill Stockpiles
   1. Drainage aggregate or backfill material shall not be piled over unstable slopes or areas of the project site with buried utilities.
   2. Drainage aggregate and/or reinforced fill material shall not be staged where it may become mixed with or contaminated by poor draining fine-grained soils such as clay or silt.

PART 2 – MATERIALS

2.1 PRECAST MODULAR BLOCK RETAINING WALL UNITS

A. All units shall be wet-cast precast modular retaining wall units conforming to ASTM C1776.

B. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years or the total time the manufacturer has been licensed, whichever is less.

C. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the properties as shown in the following table:

END OF SECTION 32 32 23

Concrete Mix Properties

Freeze Thaw Exposure Class[1]	Minimum 28-Day Compressive Strength[2]	Maximum Water Cement Ratio	Nominal Maximum Aggregate Size	Aggregate Class Designation[3]	Air Content[4]
Moderate	4,000 psi (27.6 MPa)	0.45	1 inch (25 mm)	3M	4.5% +/- 1.5%
Severe	4,000 psi (27.6 MPa)	0.45	1 inch (25 mm)	3S	6.0% +/- 1.5%
Very Severe	4,500 psi (30.0 MPa)	0.40	1 inch (25 mm)	4S	6.0% +/- 1.5%
Maximum Water-Soluble Chloride Ion (Cl^-) Content in Concrete, Percent by Weight of Cement[5,6]					0.15
Maximum Chloride as Cl^- Concentration in Mixing Water, Parts Per Million					1000
Maximum Percentage of Total Cementitious Materials By Weight [7,9] (Very Severe Exposure Class Only):					
Fly Ash or Other Pozzolans Conforming to ASTM C618					25
Slag Conforming to ASTM C989					50
Silica Fume Conforming to ASTM C1240					10
Total of Fly Ash or Other Pozzolans, Slag, and Silica Fume[8]					50
Total of Fly Ash or Other Pozzolans and Silica Fume[8]					35
Alkali-Aggregate Reactivity Mitigation per ACI 201					
Slump (Conventional Concrete) per ASTM C143[10]					5 inches +/- 1½ inches (125 mm +/- 40 mm)
Slump Flow (Self-Consolidating Concrete) per ASTM C1611					18 inches – 32 inches (450 mm – 800 mm)

[1]Exposure class is as described in ACI 318. "Moderate" describes concrete that is exposed to freezing and thawing cycles and occasional exposure to moisture. "Severe" describes concrete that is exposed to freezing and thawing cycles and in continuous contact with moisture. "Very Severe" describes concrete that is exposed to freezing and thawing cycles and in continuous contact with moisture and exposed to deicing chemicals. Exposure class should be specified by owner/purchaser prior to order placement.

[2]Test method ASTM C39.
[3]Defined in ASTM C33 Table 3 *Limits for Deleterious Substances and Physical Property Requirements of Coarse Aggregates for Concrete*.
[4]Test method ASTM C231.
[5]Test method ASTM C1218 at age between 28 and 42 days.
[6]Where used in high sulfate environments or where alkali-silica reactivity is an issue, water soluble chloride shall be limited to no more than trace amounts (from impurities in concrete-making components, not intended constituents.)
[7]The total cementitious material also includes ASTM C150, C595, C845, C1157 cement. The maximum percentages shall include:

(a) Fly ash or other pozzolans in type IP, blended cement, ASTM C595, or ASTM C1157.

(b) Slag used in the manufacture of an IS blended cement, ASTM C595, or ASTM C1157.

(c) Silica fume, ASTM C1240, present in a blended cement.

[8]Fly ash or other pozzolans and silica fume shall constitute no more than 25 and 10 percent, respectively, of the total weight of the cementitious materials.

[9]Prescriptive limits shown may be waived for concrete mixes that demonstrate excellent freeze/thaw durability in a detailed and current testing program.

[10]Slump may be increased by a high-range water-reducing admixture.

D. Concrete reinforcing steel, when required for the specified block, shall conform to ASTM A615 and have a minimum yield strength of 60,000 psi. When required by the Owner to be galvanized or epoxy-coated, reinforcing steel shall conform to ASTM A767 or ASTM A775, respectively, and have a minimum yield strength of 60,000 psi.

E. At least 1 inch of concrete cover shall be maintained over all reinforcing steel bars.

F. Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the table below and be produced to the dimensional tolerances shown.

Block Type	Dimension	Nominal Value	Tolerance
28” (710 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	28” (710 mm)	+/- 1/2” (13 mm)
41” (1030 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	40-1/2” (1030 mm)	+/- 1/2” (13 mm)
60” (1520 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	60” (1520 mm)	+/- 1/2” (13 mm)
52” (1320 mm) XL Block	Height	36” (914 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	60” (1520 mm)	+/- 1/2” (13 mm)
72” (1830 mm) XL Block	Height	36” (914 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	60” (1520 mm)	+/- 1/2” (13 mm)
96” (2440 mm) XL Block	Height	36” (914 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	60” (1520 mm)	+/- 1/2” (13 mm)

* Block tolerance measurements shall exclude variable face texture

G. With the exception of half-block units, corner units and other special application units, the precast modular block units shall have two (2), circular dome shear knobs that are 10 inches (254 mm), 7.5 inches (190 mm), or 6.75 inches (171 mm) in diameter and 4 inches (102 mm) or 2 inches (51 mm) in height. The shear knobs shall fully index into a continuous semi-cylindrical shear channel in the bottom of the block

course above. ThePeak interlock shear between any two (2) vertically stacked precast modular block units, with 10-inch (254 mm) diameter shear knobs, measured in accordance with ASTM D6916 shall exceed 6,500 lb/ft (95 kN/m) at a minimum normal load of 500 lb/ft (7kN/m). as well as an ultimate peak interface shear capacity in excess of 11,000 lb/ft (160 kN/m). The peak interlock shear between any two (2) vertically stacked precast modular block units, with 7.5-inch (190 mm) or 6.75-inch (171 mm) diameter shear knobs, measured in accordance with ASTM D6916 shall exceed 1,850 lb/ft (27 kN/m) at a minimum normal load of 500 lb/ft (7kN/m) as well as an ultimate peak interface shear capacity in excess of 10,000 lb/ft (146 kN/m).Test specimen blocks tested under ASTM D6916 shall be actual, full-scale production blocks of known compressive strength. The interface shear capacity reported shall be corrected for a 4,000 psi (27.6 MPa) concrete compressive strength. Regardless of precast modular block configuration, interface shear testing shall be completed without the inclusion of unit core infill aggr
e
gate.

H. The 28-inch (710 mm) and 41-inch (1030 mm) precast modular block units may be cast with a continuous vertical core slot that will permit the insertion of a 12-inch (305 mm) inch wide strip of geogrid reinforcement to pass completely through the block. When installed in this manner, the geogrid reinforcement shall form a non-normal load dependent, positive connection between the block unit and the reinforcement strip. The use of steel for the purposes of creating the geogrid-to-block connection is not ac
c
eptable.

I. Without field cutting or special modification, the precast modular block units shall be capable of achieving a minimum radius of 14 ft - 6 in (4.42 m).

J. The precast modular block units shall be manufactured with an integrally cast shear knobs that establishes a standard horizontal set-back for subsequent block courses. The precast modular block system shall be available in the standard horizontal set-back facing batter options listed below:

18-inch High Blocks Horizontal Set-Back/Blk. Course	Max. Facing Batter
3/8” (10 mm)	1.2˚
1-5/8” (41 mm)	5.2˚
9-3/8” (238 mm)	27.5˚
16-5/8” (422 mm)	42.7˚

36-inch High Blocks Horizontal Set-Back/Blk. Course	Max. Facing Batter
3-1/4” (83 mm)	5.2˚

The precast modular block units shall be furnished with the required shear knobs that provide the facing batter required in the construction shop drawings.

K. The precast modular block unit face texture shall be selected by the owner from the available range of textures available from the precast modular block manufacturer. Each textured block facing unit shall be a minimum of 5.76 square feet (0.54 square meters) with a unique texture pattern that repeats with a maximum frequency of once in any 15 square feet (1.4 square meters) of wall face.

L. The block color shall be selected by the owner from the available range of colors available from the precast modular block manufacturer.

M. All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall. PMB units to be used in exposed wall construction shall not exhibit chips or cracks in the exposed face or faces of the unit that are not otherwise permitted. Chips smaller than 1.5” (38 mm) in its largest dimension and cracks not wider than 0.012” (0.3 mm) and not longer than 25% of the nominal hei
g
ht of the PMB unit shall be permitted. PMB units with bug holes in the exposed architectural face smaller than 0.75” (19 mm) in its largest dimension shall be permitted. Bug holes, water marks, and color variation on non-architectural faces are acceptable. PMB units that exhibit cracks that are continuous through any solid element of the PMB unit shall not be incorporated in the work regardless of the width or length of the crack.

N. Preapproved Manufacturers.
Manufacturers of Redi-Rock Retaining Wall Systems as licensed by Redi-Rock International, LLC, 05481 US 31 South, Charlevoix, MI 49720 USA; telephone (866) 222-8400; website www.redi-rock.com.

O. Substitutions. Technical information demonstrating conformance with the requirements of this specification for an alternative precast modular block retaining wall system must be submitted for preapproval at least 14 calendar days prior to the bid date. Acceptable alternative PMB retaining wall systems, otherwise found to be in conformance with this specification, shall be approved in writing by the owner 7 days prior to the bid date. The Owner’s Representative reserves the right to provide no respons
e
to submissions made out of the time requirements of this section or to submissions of block retaining wall systems that are determined to be unacceptable to the owner.

P. Value Engineering Alternatives. The owner may evaluate and accept systems that meet the requirements of this specification after the bid date that provide a minimum cost savings of 20% to the Owner. Construction expediency will not be considered as a contributing portion of the cost savings total.

2.2 GEOGRID REINFORCEMENT

A. Geogrid reinforcement shall be a woven or knitted PVC coated geogrid manufactured from high-tenacity PET polyester fiber with an average molecular weight greater than 25,000 (M_n > 25,0000) and a carboxyl end group less than 30 (CEG < 30). The geogrid shall be furnished in prefabricated roll widths of certified tensile strength by the manufacturer. The prefabricated roll width of the geogrid shall be 12" (300 mm) +/- 1/2" (13 mm). No cutting of geogrid reinforcement down to the 12" (300 mm) roll width from a larger commercial roll width will be allowed under any circumstances.

B. The ultimate tensile strength (T_{ult}) of the geogrid reinforcement shall be measured in accordance with ASTM D6637.

C. Geogrid – Soil Friction Properties
   1. Friction factor, F*, shall be equal to 2/3 Tan ϕ, where ϕ is the effective angle of internal friction of the reinforced fill soil.
   2. Linear Scale Correction Factor, α, shall equal 0.8.

D. Long-Term Tensile Strength (T_{al}) of the geogrid reinforcement shall be calculated in accordance with Section 3.5.2 of FHWA-NHI-10-024 and as provided in this specification.
   1. The creep reduction factor (RF_{CR}) shall be determined in accordance with Appendix D of FHWA-NHI-10-025 for a minimum 75 year design life.
   2. Minimum installation damage reduction factor (RF_{ID}) shall be 1.25. The value of RF_{ID} shall be based upon documented full-scale tests in a soil that is comparable to the material proposed for use as reinforced backfill in accordance with ASTM D5818.
   3. Minimum durability reduction factor (RF_D) shall be 1.3 for a soil pH range of 3 to 9.

E. Connection between the PMB retaining wall unit and the geogrid reinforcement shall be determined from short-term testing per the requirements of FHWA NHI-10-025, Appendix B.4 for a minimum 75-year design life.

F. The minimum value of T_{al} for geogrid used in design of a reinforced precast modular block retaining wall shall be 2,000 lb/ft (29 kN/m) or greater.

G. The minimum length of geogrid reinforcement shall be the greater of the following:
   1. 0.7 times the wall design height, H.
   2. 6 feet (1.83 m).
   3. The length required by design to meet internal stability requirements, soil bearing pressure requirements and constructability requirements.

H. Constructability Requirements. Geogrid design embedment length shall be measured from the back of the precast modular block facing unit and shall be consistent for the entire height of a given retaining wall section.

I. Geogrid shall be positively connected to every precast modular block unit. Design coverage ratio, Rc, as calculated in accordance with AASHTO LRFD Bridge Design Specifications Figure 11.10.6.4.1-2 shall not exceed 0.50.

J. Preapproved Geogrid Reinforcement Products.
   1. Miragrid XT Geogrids as manufactured by TenCate Geosynthetics of Pendergrass, Georgia USA and distributed by Manufacturers of the Redi-Rock Retaining Wall System.

K. Substitutions. No substitutions of geogrid reinforcement products shall be allowed.

2.3 GEOTEXTILE

A. Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. Additionally, the nonwoven geotextile fabric shall be placed in the v-shaped joint between adjacent block units on the same course. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288.

B. Preapproved Nonwoven Geotextile Products
   1. Mirafi 140N
   2. Propex Geotex 451
   3. Skaps GT-142
   4. Thrace-Linq 140EX
   5. Carthage Mills FX-40HS
   6. Stratatex ST 142

2.4 DRAINAGE AGGREGATE AND WALL INFILL

A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASTM D6913:

U.S. Standard Sieve Size	% Passing
1-½" (38 mm)	100
1" (25 mm)	95-100
½" (13 mm)	25-60
No. 4 (4.76 mm)	0-10
No. 8 (2.38 mm)	0-5

2.5 REINFORCED FILL

A. Material used as reinforced backfill material in the reinforced zone (if applicable) shall be a granular fill material meeting the requirements of USCS soil type GW, GP, SW or SP per ASTM D2487 or alternatively by AASHTO Group Classification A-1-a

or A-3 per AASHTO M 145. The backfill shall exhibit a minimum effective internal angle of friction, ϕ = 34 degrees at a maximum 2% shear strain and meet the following particle-size distribution requirements per ASTM D6913.

U.S. Standard Sieve Size	% Passing
3/4" (19 mm)	100
No. 4 (4.76 mm)	0-100
No. 40 (0.42 mm)	0-60
No. 200 (0.07 mm)	0-15

B. The reinforced backfill material shall be free of sod, peat, roots or other organic or deleterious matter including, but not limited to, ice, snow or frozen soils. Materials passing the No. 40 (0.42 mm) sieve shall have a liquid limit less than 25 and plasticity index less than 6 per ASTM D4318. Organic content in the backfill material shall be less than 1% per AASHTO T-267 and the pH of the backfill material shall be between 5 and 8.

C. Soundness. The reinforced backfill material shall exhibit a magnesium sulfate soundness loss of less than 30% after four (4) cycles, or sodium sulfate soundness loss of less than 15% after five (5) cycles as measured in accordance with AASHTO T-104.

D. Reinforced backfill shall not be comprised of crushed or recycled concrete, recycled asphalt, bottom ash, shale or any other material that may degrade, creep or experience a loss in shear strength or a change in pH over time.

2.6 LEVELING PAD

A. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the RWDE.

B. Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in section 2.04 or a preapproved alternate material.

C. Concrete used for construction of an unreinforced concrete leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi (17.2 MPa).

2.7 DRAINAGE

A. Drainage Pipe
   1. Drainage collection pipe shall be a 4" (100 mm) diameter, 3-hole perforated, HDPE pipe with a minimum pipe stiffness of 22 psi (152 kPa) per ASTM D2412.

2. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.

B. Preapproved Drainage Pipe Products
1. ADS 3000 Triple Wall pipe as manufactured by Advanced Drainage Systems, or Equal.

PART 3 – EXECUTION

3.01 GENERAL

A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer's requirements.

B. The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.

C. New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.

D. The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.

E. All work shall be inspected by the Inspection Engineer as directed by the Owner.

3.02 EXAMINATION

A. Prior to construction, the General Contractor, Grading Contractor, RWIC and Inspection Engineer shall examine the areas in which the retaining wall will be constructed to evaluate compliance with the requirements for installation tolerances, worker safety and any site conditions affecting performance of the completed structure. Installation shall proceed only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Fill Soil.
1. The Inspection Engineer shall verify that reinforced backfill placed in the reinforced soil zone satisfies the criteria of this section.
2. The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the RWDE as shown on the construction drawings.

B. Excavation.
   1. The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.
   2. Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the RWDE and “Division 31, Section 31 20 00 – Earthmoving” of these project specifications
   .
   3. Embankment excavations shall be bench cut as directed by the project Geotechnical Engineer and inspected by the Inspection Engineer for compliance.

C. Foundation Preparation.
   1. Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed. Additional foundation soils found to be unsatisfactory beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits a
   re consistent with the requ
   irements of the project Geotechnical Engineer and that all soil fill material is properly compacted in accordance with project specifications. The Inspection Engineer shall document the volume of undercut and replacement.
   2. Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.
      a. The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the RWDE is appropriate. The Inspection Engineer shall immediately stop work and notify the Owner if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.
      b. The Inspection Engineer shall verify that the foundation soil exhibits sufficient ultimate bearing capacity to satisfy the requirements indicated on the retaining wall construction shop drawings per paragraph 1.06
      I of this section.

D. Leveling Pad.
   1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions shown on the retaining wall construction drawings and extend to the limits indicated.
   2. Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 6” (150 mm). The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 lb (8.9 kN) of c
   entrifugal force and to the satisfaction of the Inspection Engineer.

3. Unreinforced Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The RWIC shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.

3.04 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION

A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer's recommendations and these specifications, these specifications shall prevail.

B. Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.

C. Precast Modular Block Installation
1. The first course of block units shall be placed with the front face edges tightly abutted together on the prepared leveling pad at the locations and elevations shown on the construction drawings. The RWIC shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.
2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks to a minimum distance of 12" (300 mm) behind the block unit. If stone infill of hollow core blocks exceeds 45% of the block design volume, drainage aggregate will not be required to extend beyond the back of the blocks,
with the approval of the RWDE.
3. Drainage aggregate shall be placed in 9-inch maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 2,000 lb (8.9 kN) of centrifugal force.
4. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of p
recast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.
5. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard item 4 above, for the base course blocks in this application.
6. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the retained soil (gravity wall design) or between the drainage aggregate and the reinforced fill (reinforced wall design) as required on the retaining wall construction drawings.

7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90-degree corner units, the shear channel of the upper block shall be fully engaged with the shear knob
s of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Geogrid, drainage aggregate, unit core fill, geotextile and properl
y compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.
8. The elevation of retained soil fill shall not be less than 1 block course (18 inches (457 mm)) below the elevation of the reinforced backfill throughout the construction of the retaining wall.
9. If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.

D. Geogrid Reinforcement Installation (if required)
1. Geogrid reinforcement shall be installed at the locations and elevations shown on the construction drawings on level fill compacted to the requirements of this specification.
2. Continuous 12" (300 mm) wide strips of geogrid reinforcement shall be passed completely through the vertical core slot of the precast modular block unit and extended to the embedment length shown on the construction plans. The strips shall be staked or anchored as necessary to maintain a taut condition.
3. Reinforcement length (L) of the geogrid reinforcement is measured from the back of the precast modular block unit. The cut length (L_c) is two times the reinforcement length plus additional length through the block facing unit. The cut length is calculated as follows:

L_c = 2*L + 3 ft (2*L + 0.9 m) (28" (710 mm) block unit)
L_c = 2*L + 5 ft (2*L + 1.5 m) (41" (1030 mm) block unit)

4. The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths of 12" (300 mm)+/- ½" (13 mm). No field modification of the geogrid roll width shall be permitted.
5. Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 5 mph (8 km/hr) once a minimum of 9 inches (230 mm) of compacted fill has be
en placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.

E. Construction Tolerance. Allowable construction tolerance of the retaining wall shall be as follows:

1. Deviation from the design batter and horizontal alignment, when measured along a 10’ (3 m) straight wall section, shall not exceed 3/4” (19 mm).
2. Deviation from the overall design batter shall not exceed 1/2“ (13 mm) per 10’ (3 m) of wall height.
3. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 1/2” (13 mm).
4. The base of the precast modular block wall excavation shall be within 2” (50 mm) of the staked elevations, unless otherwise approved by the Inspection Engineer.
5. Differential vertical settlement of the face shall not exceed 1’ (300 mm) along any 200’ (61 m) of wall length.
6. The maximum allowable vertical displacement of the face in any precast modular block joint shall be 1/2“ (13 mm).
7. The wall face shall be placed within 2” (50 mm) of the horizontal location staked.

3.05 WALL INFILL AND REINFORCED BACKFILL PLACEMENT

A. Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:
   1. 98% of maximum dry density at ± 2% optimum moisture content per ASTM D698 standard proctor or 85% relative density per ASTM D4254.

B. Compactive effort within 3’ (0.9 m) of the back of the precast modular blocks should be accomplished with walk-behind compactors. Compaction in this zone shall be within 95% of maximum dry density as measured in accordance with ASTM D698 standard proctor or 80% relative density per ASTM D 4254. Heavy equipment should not be operated within 3’ (0.9 m) of the back of the precast modular blocks.

C. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 9” (230 mm).

D. At the end of each work day, the RWIC shall grade the surface of the last lift of the granular wall infill to a 3% ± 1% slope away from the precast modular block wall face and compact it.

E. The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.

3.06 OBSTRUCTIONS IN THE INFILL AND REINFORCED FILL ZONE

A. The RWIC shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.

B. Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be con-

structed until the RWDE can appropriately address the required procedures for construction of the wall section in question.

3.07 COMPLETION

A. For walls supporting unpaved areas, a minimum of 12” (300 mm) of compacted, low-permeability fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.

B. For retaining walls with crest slopes of 5H:1V or steeper, silt fence shall be installed along the wall crest immediately following construction. The silt fence shall be located 3’ to 4’ (0.9 m to 1.2 m) behind the uppermost precast modular block unit. The crest slope above the wall shall be immediately seeded to establish vegetation. The General Contractor shall ensure that the seeded slope receives adequate irrigation and erosion protection to support germination and growth.

C. The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Owner of any deviations.

END OF SECTION 32 32 16

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SECTION 32 32 23 – DRY-LAID STONE WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dry-laid stone walls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show sizes, profiles, coursing, and locations of wall units; including backfill and leveling base materials.
   2. Show types, sizes, locations of soil materials.

C. Samples for Verification: Actual sample of finished products for each type of exposed finish of wall units.
   1. Size: sections of units not less than 6 inches square.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Installers: Entity that employs installers with a minimum of 5 years experience with the installation of dry-laid stone wall.

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.
   1. Build mockup of stone wall approximately 72 inches long by not less than 18 inches high above finished grade at front of wall.
      a. Include typical base and cap or finished top construction.
      b. Include backfill to typical finished grades at both sides of wall.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone 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 use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 STONE WALL UNITS

A. Bluestone Matching Existing: Natural stone of variety, color, texture, grain, veining, finish, size, and shape that match existing stone.
   1. For existing stone that exhibits a range of colors, textures, grains, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.
   2. Refer to Drawings for size and finish.

2.2 INSTALLATION MATERIALS

A. Adhesive: Product supplied or recommended for adhering bluestone units.

B. Leveling Base: Comply with requirements in Section 31 20 00 "Earth Moving" for base course.

C. Drainage Fill: Comply with requirements in Section 31 20 00 "Earth Moving" for drainage course.

D. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation of greater than 50 percent.
   1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D4751.
   2. Minimum Grab Tensile Strength: 110 lb; ASTM D4632/D4632M.
   3. Minimum Weight: 4 oz./sq. yd..

PART 3 - EXECUTION

3.1 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 the Work.

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

3.2 INSTALLATION OF DRY-LAID STONE WALLS

A. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet where such defects are exposed in the completed Work.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight in accordance with ASTM D698.

C. First Course: Place first course of stone 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 stone units in course below. Place stone units in firm contact, properly aligned, and directly on course below.
   1. Stone and Stone Cap Units: Place stone units and secure with adhesive.

3.3 FILL PLACEMENT

A. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

B. 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 stone 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 in accordance with ASTM D698.
   3. Compact nonreinforced-soil fill to comply with Section 31 20 00 "Earth Moving."

C. 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.

D. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated.

F. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

3.4 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.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

D. Maximum Gap between Units: 1/8 inch.

3.5 ADJUSTING

A. Remove and replace stone wall construction of the following descriptions:
   1. Broken, chipped, stained, or otherwise damaged units.
   2. Stone walls that do not match existing adjacent walls.
   3. Stone walls that do not comply with other requirements indicated.

END OF SECTION 32 32 23

SECTION 32 33 53 – CUT STONE SEATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cut stone seating.

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Material Test Reports:
   1. Stone Test Reports: For stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, according to referenced ASTM standards. Base reports on testing within previous five years.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.
   1. Show locations and details of joints both within stone seating and between stone seating and other finish materials.
   2. Show direction of veining, grain, or other directional patterns.

C. Samples for Initial Selection: For joint materials involving color selection.

D. Samples for Verification:
   1. For each stone type indicated, in sets of Samples not less than 12 inches square. Include at least three or more Samples in each set and show the full range of color and other visual characteristics in completed Work.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stone seating to include in maintenance manuals. Include product data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone seating.

B. Installer Qualifications: A firm or individual experienced in installing exterior stone seating similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
   1. Build mockup of typical exterior stone seating as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
   1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
   2. Store stone on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Mark stone units, on surface that is concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels, so that they are right side up when units are installed.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.7 FIELD CONDITIONS

A. Maintain air and material temperatures to comply with requirements of installation material manufacturers, but not less than 50 deg F during installation and for seven days after completion.

B. Cold-Weather Requirements for Exterior Stone Seating: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone seating damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CUT STONE SEATING

A. Cut stone seating is to be structurally sound, durable, free from rifts, seams, laminations, cracking, scaling or other evidence of disintegration.
   1. Type: Woodbury Granite.
   2. Size/Shape: As indicated on Drawings.
   3. Color: Salt and Pepper colors acceptable to Landscape Architect.
   4. Finish: Thermal finish on all exposed sides.

5. Seatwall edges to have a ¼” eased edge.
6. Material Standard: Comply with ASTM C615/C615M.

2.2 FABRICATION OF STONE

A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.

B. Fabricate stone to comply with requirements indicated and with the following references:
   1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."

C. Fabricate stone seating in sizes and profiles indicated.

D. Carefully inspect finished stone units at fabrication plant for compliance with appearance, material, and fabrication requirements. Replace defective units. Clean sawn backs of stones to remove rust stains and iron particles.
   1. Grade and select stone for overall uniform appearance when assembled in place.
   2. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, aggregate setting beds, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Sweep stone to remove dirt, dust, debris, and loose particles.

B. Before setting stone, clean dirty or stained stone surfaces by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 CUT STONE SEATING INSTALLATION, GENERAL

A. Excavate and prepare area on which cut stone seating is to be placed according to Drawings.

B. After stone seating location is complete and ready for placement, mark layout by referencing the front face of seating based on Drawings. Final layout will be approved by Landscape Architect.

C. After arrangement of stone seating is approved, set stones in place, true to surrounding cross-slope and grade, and free of any movement or rocking. Backfill and shim with stone as needed to eliminate movement.

D. Keep all joints free of mortar and other rigid materials.

3.4 INSTALLATION TOLERANCES

A. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/16 inch or one-fourth of nominal joint width on all exposed sides, whichever is less.

B. Variation in Surface Plane: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum from level or slope indicated.

C. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/32-inch difference between planes of adjacent units.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stones of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Landscape Architect.
   2. Defective joints.
   3. Stones not complying with other requirements indicated.

B. Replace in a manner that results in stones matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stones as work progresses.

D. Clean stones after setting is complete. Use procedures recommended by stone fabricator for application types.

END OF SECTION 32 33 53

SECTION 32 33 54 – CUT STONE STEPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cut stone steps on concrete footings with mortar setting bed

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Material Test Reports:
   1. Stone Test Reports: For stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, according to referenced ASTM standards. Base reports on testing within previous five years.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.
   1. Show locations and details of joints both within stone seating and between stone seating and other finish materials.
   2. Show direction of veining, grain, or other directional patterns.

C. Samples for Verification:
   1. Submit photos of the materials to the Landscape Architect for approval. Photos should communicate the approximate dimensions and color ranges of the stone. Photos shall be sent to Landscape Architect no later than six weeks prior to delivery of material on the project site.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stone seating to include in maintenance manuals. Include product data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone steps.

B. Installer Qualifications: A firm or individual experienced in installing exterior stone steps similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
   1. Build mockup of typical exterior steps as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
   1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
   2. Store stone steps on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Cut stone steps are to be stored at an approved location for use prior to final placement. Stone steps are not to be stored in mud or lawn areas.

C. Cut stone steps are not to be stored within 20 feet of any tree, power pole, streetlight pole, or hydrant, nor any monument or utility appurtenance.

D. Mark stone units, on surface that is concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels, so that they are right side up when units are installed.

1.7 FIELD CONDITIONS

A. Maintain air and material temperatures to comply with requirements of installation material manufacturers, but not less than 50 deg F during installation and for seven days after completion.

B. Cold-Weather Requirements for Exterior Stone Steps: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone steps damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CUT STONE STEPS

A. Cut stone steps are to be structurally sound, durable, free from rifts, seams, laminations, cracking, scaling or other evidence of disintegration.
   1. Type: Woodbury granite, matching in character to the existing materials.

2. Size/Shape: Salt and pepper matching existing site materials and sawn on all 6 faces.
3. Color: Medium Gray colors acceptable to Landscape Architect.
4. Finish: Thermal finish on all 6 faces.
5. Material Standard: Comply with ASTM C615/C615M.

2.2 FABRICATION OF STONE

A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.

B. Fabricate stone to comply with requirements indicated and with the following references:
1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."

C. Fabricate stone steps in sizes and profiles indicated to best integrate with existing salvaged granite treads from site.

D. Carefully inspect finished stone units at fabrication plant for compliance with appearance, material, and fabrication requirements. Replace defective units. Clean sawn backs of stones to remove rust stains and iron particles.
1. Grade and select stone for overall uniform appearance when assembled in place that blends naturally with the existing salvaged treads.
2. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, aggregate setting beds, installation tolerances, footings, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Before setting stone, clean dirty or stained stone surfaces by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 CUT STONE STEPS INSTALLATION, GENERAL

A. Cut stone steps to comply with requirements indicated.

B. Stone steps are to be set on a mortar setting bed with proper grade of mortar, set upon cast-in-place concrete footings (refer to Civil specifications set).

C. All steps should be set with an overlap to maintain required tread depth as indicated on drawings.

D. All steps shall be set level side to side and front to back for the entire run of steps to be constructed.

E. All joints shall be staggered.

3.4 INSTALLATION TOLERANCES

A. Variation in Joint Width: Design intent is for no spaced joints in stone step installation. Refer to Drawings for layout.

B. Variation in Surface Plane: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum from level or slope indicated.

C. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/32-inch difference between planes of adjacent units.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stonework of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone.
   2. Defective joints.
   3. Stonework not complying with other requirements indicated.

B. Replace in a manner that results in stone matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stones as work progresses.

D. Clean stonework after setting is complete. Use procedures recommended by stone fabricator for application types.

END OF SECTION 32 33 53

SECTION 32 33 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Landscape Boulders.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: Contractor shall have Landscape Architect to conduct quarry site visit to select landscape boulders with contractor.

C. Samples for Verification:
   1. The Contractor shall submit photos of the materials to the Landscape Architect for approval. Photos should communicate the approximate dimensions and color ranges of the boulders. Photos shall be sent to Landscape Architect no later than six weeks prior to delivery of material on the project site. Contractor shall not deliver any boulder to the project until approved by Landscape Architect.

1.4 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.
   1. Build mockup of a minimum of 3 courses of each landscape boulder wall.
      a. Include backfill to typical finished grades at both sides of wall.
      b. Include typical end construction at one end of mockup.
      c. Include 36-inch return at one end of mockup, with typical corner construction.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 LANDSCAPE BOULDERS

A. Landscape boulders are to be structurally sound, durable, free of structural cracking, and are to be clean, free of soil and mud.
   1. Type: Mossy Hill Boulders; New York Quarries.
   2. Shape:

a. Feature boulders are to be shaped per drawings drilled and split stones with a natural form. See plans for locations.
b. All other boulders to be shaped as pulled from the quarry.

3. Size Range: Boulders should be selected from the following percentage ranges.
   a. Wall stones/Two man Boulders = 10%
   b. 1-3 Ton Boulders = 30-40%
   c. 3-5 Ton Boulders = 50-60%
4. Size Tolerances: Boulder length of 24 inches to 60 inches.
   a. Overall height variation (+/-) 3 to 4 inches.
   b. Overall widths variation (+/-) 6 inches.
5. Color: Brown and grey in ranges acceptable to Landscape Architect.
   a. Landscape Architect to select stones to be placed on site from delivery load.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 LANDSCAPE BOULDER INSTALLATION

A. Landscape boulders are to be stockpiled at an approved location for use prior to final placement. Landscape boulders are not to be stored in mud or lawn areas. If that is only available location, boulders need to be placed on wood palettes or lumber that is sufficient in height to keep boulders off ground surface to allow mechanical lifting of boulders without damage to materials.

B. Boulder installation shall be done in a manner to minimize mechanical abrasion, chipping or breakage by grabbing, lifting, pushing boulders via equipment buckets, clamps, attachments or other implements.

C. Boulders should be cleaned to remove any debris or loose materials from the quarry prior to placement.

D. Any adjustment to boulder sizing or required cuts shall be done in the field.

E. Landscape boulders are not to be placed within 20 feet of any tree, power pole, street light pole, or hydrant, nor over any monument or utility appurtenance.

F. Layout
   1. See plans for critical height dimensions and layout. Contractor is responsible for placement and meeting the limits of the boulder feature as shown in the layout plans. If design intent can’t be met inform Landscape Architect immediately.

2. Acceptable tolerances for vertical layout are < 1". Horizontal layout tolerances are within 4"-6".
    a. Vertical height differences between boulders courses must be below 30" in elevation change with a minimum of 24" of horizontal surface extending past the drop.
3. Joints
    a. All boulder joints along exposed surfaces (top or sides) should be as tight as possible with gaps being no more than 2" wide
    b. Joint gaps that are larger than 2" wide should be filled in with either
        1) smaller wall stones with mortar infill
        2) approved mortar
        3) planting soil
    c. All joints between courses shall be staggered.
4. Maintain a minimum of clearance from building and site walls as indicated in the plans.
5. See plans for areas where boulder feature meet site stair elements and stone seat walls. In these locations the faces butting against features shall be as minimal as possible. < 1"

G. Excavate and prepare area on which landscape boulders are to be placed according to Drawings.

H. After Landscape boulder location is complete and ready for placement, mark layout by referencing the front face of boulders based on Drawings. Final layout will be approved by Landscape Architect.

I. After arrangement of landscape boulders is approved, set landscape boulders in place, true to surrounding cross-slope and grade, and free of any movement or rocking. Backfill and shim with stone as needed to eliminate movement.

3.3 CLEANING

A. Landscape boulders are to be cleaned of any marks and scars caused by construction operations and construction equipment.

B. All stone fragments and debris from installation are to be removed from Project site.

END OF SECTION 32 33 00

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SECTION 32 91 13 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

1.2 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include recommendations for application and use.
   2. Include test data substantiating that products comply with requirements.
   3. Include sieve analyses for aggregate materials.
   4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
      a. Manufacturer's qualified testing agency's certified analysis of standard products.
      b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
      c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
   1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
   1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
   1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.7 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect under the direction of the testing agency.
   1. Number and Location of Samples: Minimum of three representative soil samples from each on-site and off-site stockpile locations or as directed by Landscape Architect] each soil to be used or amended for landscaping purposes.
   2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils," And to be confirmed by Landscape Architect.
   3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
   4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.8 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:
   1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
      a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
      b. Hydrometer Method: Report percentages of sand, silt, and clay.
   2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
   3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."

4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).

C. Chemical Testing:
   1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
   2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
   3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
   4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13 including the following:
   1. Percentage of organic matter.
   2. CEC, calcium percent of CEC, and magnesium percent of CEC.
   3. Soil reaction (acidity/alkalinity pH value).
   4. Buffered acidity or alkalinity.
   5. Nitrogen ppm.
   6. Phosphorous ppm.
   7. Potassium ppm.
   8. Manganese ppm.
   9. Manganese-availability ppm.
   10. Zinc ppm.
   11. Zinc availability ppm.
   12. Copper ppm.
   13. Sodium ppm and sodium absorption ratio.
   14. Soluble-salts ppm.
   15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
   16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight for 1000 sq. ft. for 6-inch depth of soil.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 TOPSOIL (ON-SITE)

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
1. Ratio of Loose Compost to Soil: 1:4 by volume.
2. Ratio of Loose Sphagnum Peat to Soil: 1:4 by volume.
3. Weight of Lime: .5 per 1000 sq. ft. per 6 inches of soil depth, based on the recommendations of soils analysis and direction of the Landscape Architect.
4. Weight of Sulfur: .25 lbs. per 1000 sq. ft. per 6 inches of soil depth, based on recommendations of soil tests and direction of the Landscape Architect
5. Weight of Agricultural Gypsum: .25 lbs. per 1000 sq. ft. per 6 inches of soil depth. based on recommendations of soil analysis and direction of the Landscape Architect
6. Weight of Commercial Fertilizer: 1 lb. per 1000 sq. ft. per 6 inches of soil depth, or
7. Weight of Slow-Release Fertilizer: 1 lb. per 1000 sq. ft. per 6 inches of soil depth.

2.2 TOPSOIL (IMPORTED):

A. Imported, naturally formed soil from off-site sources and consisting of loam soil according to USDA textures; and modified to produce viable planting soil.
   1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
   2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6.5 to 7.2 and minimum of 5 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
   3. Unacceptable Properties: Clean soil of the following:
      a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
      b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
      c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1 inch in any dimension.
   4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil: Refer to B 1-7 above.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
   2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.

B. Form: Provide lime in form of ground dolomitic limestone. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve. (or)

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
   1. Feedstock: May include sewage sludge USCC reaction range requirement is pH of 5.0 to 8.5.
   2. Reaction: pH of 6.0 to 8.0
   3. Soluble-Salt Concentration: Less than 4 dS/m.
   4. Moisture Content: 35 to 55 percent by weight.
   5. Organic-Matter Content: 35 to 60 percent of dry weight.
   6. Particle Size: Minimum of 98 percent passing through a 3/4-inch sieve.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: 1 lb./1000 sq. ft. 20-25 of actual nitrogen, and 5-11 percent potassium, by weight.
   2. Composition: Nitrogen, and potassium in amounts recommended in soil reports from a qualified testing agency.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, and potassium in the following composition:
   1. Composition: 20 percent nitrogen, and 10 percent potassium, by weight.
   2. Composition: Nitrogen, , and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

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

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches in accordance with depths indicated on boring analysis and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 5 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 1-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 6 inches or as indicated on Drawings, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
   1. Amendments: Apply soil amendments**,** except compost**,** and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
      a. Mix lime and sulfur with dry soil before mixing fertilizer.
      b. Mix fertilizer with planting soil no more than seven days before planting.
   2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments**,** except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
   1. Mix lime and sulfur with dry soil before mixing fertilizer.
   2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix, 4 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Vehicle traffic.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Landscape Architect and replace contaminated planting soil with new planting soil.

3.7 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
   1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 32 91 13

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Seeding.
   2. Hydroseeding.
   3. Erosion-control material(s).

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
   1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals, the American Horticultural Society, NYS Nursery & Landscape Association or NYS Turfgrass Association.
   2. Experience: Five years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals or New York State Nursery & Landscape Association:
      a. Landscape Industry Certified Technician - Exterior.
      b. Landscape Industry Certified Lawn Care Manager.
      c. Landscape Industry Certified Lawn Care Technician
      d. Certified Nursery & Landscape Professional.
   5. Pesticide Applicator: State licensed, commercial.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk materials with appropriate certificates.

1.7 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion
   1. Spring Planting: March 15th – June 15th.
   2. Fall Planting: October 1st – December 15th.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:
1. Quality: Seed of grass species as indicated on Drawings with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, and potassium in the following composition:
1. Composition: 24 percent nitrogen, and 11 percent potassium, by weight.
2. Composition: Nitrogen, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 6 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 4.0 deci Siemens per meter dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 35-60% percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Non-asphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

E. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding and hydro mulching overspray.
   2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

~~B.~~ Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
   1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   2. Do not use wet seed or seed that is moldy or otherwise damaged.
   3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate indicated by the seed mix manufacturer unless noted otherwise in the Drawings.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer (24-0-11), and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
   1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
   2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.6 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, reseeding, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and reseed bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   1. Mow grass to a height of 3 inches.

D. Turf Postfertilization: Apply slow-release fertilizer (24-0-11) after initial mowing and when grass is dry.
   1. Use fertilizer that provides actual nitrogen of at least 0.7 lb./1000 sq. ft. to turf area.

3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.8 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.9 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout the initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.10 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than final acceptance.

B. Initial Lawn Care Service:
   1. Beginning at Substantial Completion, lawn care service shall include 12 months' comprehensive lawn care service by skilled employees of a lawn care specialist. Lawn care service shall include fertilization, weed control, and pesticides.
   2. Performing operations as required to establish healthy and green lawn. Apply treatments as required to keep turf and soil free of weeds, pests, and pathogens or disease. Use integrated weed, and pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
   3. Provide fertilization that was applied initially and extend to minimum of 5 applications per year.
   4. Weed control and grub control/pest management shall be done spring, summer, and fall.

5. Continuing Lawn Care Proposal: Submit a continuing proposal from Service Provider to Owner, in the form of a standard one-year service agreement, starting on date the initial lawn care service agreement is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

END OF SECTION 32 92 00

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plants.
2. Tree stabilization.
3. Landscape edgings.

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Ball and Burlap Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

H. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" for drawing designations for planting soils.

K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.3 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
   1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
   2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: Actual sample of finished products for each of the following:
   1. Organic Mulch: 1-pint volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
   2. Stone Mulch: 2 lb of each stone mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with source of mulch. Provide accurate indication of color, texture, and makeup.
   3. Weed-Control Barrier: 12 by 12 inches.
   4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
   5. Root Barrier: Width of panel by 12 inches.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
   1. Manufacturer's certified analysis of standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
   1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network, the American Nursery and Landscape Association or the New York State Nursery & Landscape Association.
   2. Experience: Five years' experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network or NYS Nursery & Landscape Association:
   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Interior.
   c. Landscape Industry Certified Horticultural Technician.
   d. Certified Nursery & Landscape Professional.
5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Landscape Architect will observe plant material at place of growth and at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove all rejected plant materials immediately from Project site.
1. Notify Landscape Architect of sources of planting materials at least seven days in advance of delivery to site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball, or container, not by trunk, branches or stems of plants.

F. Store bulbs, corms, and tubers in a dry place at 60 to 65 degrees F until planting.

G. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks before wrapping, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
   1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
   2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
   3. Do not remove container-grown stock from containers before time of planting.
   4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: March 15th – June 15th.
   2. Fall Planting: October 1st – December 15th.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
      b. Structural failures including plantings falling or blowing over.
      c. Faulty performance of tree stabilization and edgings.
      d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Periods: From date of Substantial Completion.
      a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
      b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
   3. Include the following remedial actions as a minimum:
      a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
      b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
      c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
      d. Provide extended warranty for period equal to original warranty period, for replaced plant material from the date of replacement and acceptance.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shape, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included

bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.

2. Trees shall have trunks that are relatively straight, vertical and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).
3. Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter. Clear trunk should be no more than 40% of the total height of the tree.
4. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
5. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. All plants including the root ball dimensions or container size to trunk caliper ratio shall conform to ANSI Z60.1 “American Standard for Nursery Stock” latest edition, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.

C. Plants larger than specified may be used if acceptable to the Landscape Architect and shall not increase the contract price. Larger sized plants may not be acceptable if the resulting root ball cannot fit properly in the required planting space.

D. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.

E. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

F. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
1. Size: 21-gram tablets.
2. Nutrient Composition: 20-25 percent nitrogen, and 5-11 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
   1. Type: Double shredded hardwood.
   2. Size Range: 3 inches maximum, 1/2 inch minimum.
   3. Color: Natural.

B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
   1. Type: Rounded riverbed gravel or smooth-faced stone.
   2. Size Range: 2 inch maximum, 3/4 inch minimum.
   3. Color: Uniform tan-beige color range acceptable to Landscape Architect.

2.4 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

2.5 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:
   1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
   2. Arbor Tie: UV-resistant, woven, polypropylene strapping.
   3. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

B. Proprietary Staking and Guying Device:
   1. Duckbill earth anchoring system 68DTS by MK Rittenhouse or similar.

2.7 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
   1. Edging Size: As indicated on Drawings
   2. Stakes: Tapered steel, a minimum of 15 inches long.
   3. Accessories: Standard tapered ends, corners, and splicers.
   4. Finish: Manufacturer's standard paint.
      a. Paint Color: Black.

2.8 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
   3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.
   1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   2. Excavate approximately three times as wide as ball diameter for balled and burlapped, and container-grown stock.
   3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
   4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
   5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
   6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
   7. Maintain supervision of excavations during working hours.
   8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
   1. Backfill: Planting soil mix. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   2. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   3. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
      a. Quantity: Per manufacturers recommendations.
   4. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
   1. Backfill: Planting soil mix. Carefully remove root ball from container without damaging root ball or plant.
   2. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   3. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
      a. Quantity: Per manufacturers recommendations.
   4. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 2 inches above adjacent finish grade.
   1. Backfill: Planting soil
   2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
   3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
   4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.
      a. Quantity: Per manufacturers recommendations.
   6. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
   1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
   2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Staking and Guying Below Grade: Install trunk stabilization as follows unless otherwise indicated on Drawings. Below grade staking and guying is required for evergreen trees only. Stake and guy trees more than 8 feet in height unless otherwise indicated.
   1. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
      a. Duckbill earth anchoring system 68DTS by MK Rittenhouse or similar.

3.8 GROUNDCOVER AND PERENNIAL PLANTING

A. Set out and space groundcover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.
   1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with minimal 30-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
   2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 EDGING INSTALLATION

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

B. Shovel-Cut Edging: Separate mulched areas from turf areas with a 45-degree, 4- to 6-inch-deep, shovel-cut edge as indicated on Drawings.

C. Mow-Strip Installation:
1. Excavate for mow strip as indicated on Drawings.
2. Compact subgrade uniformly beneath mow strip.
3. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
4. Install steel edging, delineating the edge of mow strip.
5. Install weed-control barrier before mulching, covering area of mow strip, and overlapping and pinning edges of barrier at least 6 inches and according to manufacturer's written instructions.
6. Place indicated thickness of mineral mulch, fully covering weed barrier.
7. Rake mulch to a uniform surface level with adjacent finish grades.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Landscape Architect.
   1. Submit details of proposed pruning and repairs.
   2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
   3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
   1. Provide new trees of same size as those being replaced. Species of Replacement Trees: Same species being replaced or Species selected by Landscape Architect.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove all nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

END OF SECTION 32 93 00

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SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and Fittings.
2. Nonpressure-type transition couplings.
3. Cleanouts.
4. Manholes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.6 FIELD 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 Architect and Owner no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

2.2 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
2. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.3 CLEANOUTS

A. PVC Cleanouts:

1. Source Limitations: Obtain PVC cleanouts from single manufacturer.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to clean out of same material as sewer piping.

B. Cleanout Lids and Frames:

1. Materials: Cast iron.
2. Nominal Lid and Frame Size: As indicated on Drawings.

2.4 MANHOLES

A. Designed Precast Concrete Manholes:

1. Description: ASTM C913; designed according to ASTM C890 for A-16 (ASSHTO HS20-44 in AASHTO HL), 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 C990, bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
5. Steps: Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, 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- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.

6. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. 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.

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 "SANITARY SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

C. Manhole-Cover Inserts:

1. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
2. Type: Solid.

2.5 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, 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 A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer 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 using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
5. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

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.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

    a. Unshielded, Shielded, flexible, or rigid couplings for pipes of same or slightly different OD.
    b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C891.

C. 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.

D. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 36 inches below final grade. Fill to top with concrete.

C. Backfill to grade according to Section 31 20 00 "Earth Moving."

3.9 IDENTIFICATION

A. Comply with requirements in Section 31 20 00 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. 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. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

   a. Test plastic gravity sewer piping according to ASTM F1417.
   b. Test concrete gravity sewer piping according to ASTM C1628.

7. Manholes: Perform hydraulic test according to ASTM C969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 33 31 00

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SECTION 33 42 00 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PE pipe and fittings.
2. PVC pipe and fittings.
3. Drains.
4. Manholes.
5. Polymer-concrete, channel drainage systems.
6. Cleanout.
7. Catch basins.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins and stormwater inlets: Include plans, elevations, sections, details, frames, covers, and grates.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet and vertical scale of not less than 1-inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets in accordance with manufacturer's written rigging instructions.

1.6 FIELD 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 in accordance with requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 CORRUGATED-PE PIPE AND FITTINGS

A. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.

B. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252, Type S, with smooth waterway for coupling joints.

C. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294, Type S, with smooth waterway for coupling joints.

D. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

E. Corrugated-PE Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

D. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

E. Adhesive Primer: ASTM F656.

2.3 DRAINS

A. Cast-Iron Area Drains:
1. Source Limitations: Obtain cast-iron area drains from single manufacturer.
2. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured grate. Include bottom outlet with inside caulk or spigot connection, of sizes indicated.
3. Top-Loading Classification(s): Heavy Duty.
4. Grate Openings: 1.25-inch wide by varying length

B. Plastic Yard Drain Basins:
1. Source Limitations: Obtain drain basins from single manufacturer.
2. Description: Plastic drainage structures used to change size, elevation, direction or pipe type in a pipe run. These structures also serve as a collection point where one or more drain lines converge.
3. Basin Size: 10”
4. Grate/Cover:
   a. Material: Ductile iron per ASTM A536 Grade 70-50-05
   b. Type: Grate
   c. Size: 10”

2.4 CLEANOUTS

A. PVC Cleanouts:

1. Source Limitations: Obtain PVC cleanouts from single manufacturer.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to clean out of same material as sewer piping.

B. Cleanout Lids and Frames:

1. Materials: Cast iron.
2. Nominal Lid and Frame Size: As indicated on Drawings.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum 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: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-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 C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, 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- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE 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.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

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 SEWER."
2. Material: ASTM A48/A48M, Class 35 gray iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete in accordance with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, 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 A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.7 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems
1. Source Limitations: Obtain narrow, sloped-invert channel drainage systems from single manufacturer.
2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
b. Include extension sections necessary for required depth.
c. Dimensions: r-inch inside width. Include number of units required to form total lengths indicated.
d. Frame: Gray-iron or galvanized steel for grates.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: Ductile iron or Stainless steel, as directed by Architect.

1) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.8 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C990, 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. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
8. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, 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- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60-inches.
9. Pipe Connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A48/A48M, Class 35 gray iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 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 in accordance with 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 24-inch-minimum cover.
4. Install PE corrugated sewer piping in accordance with ASTM D2321.
5. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
6. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:
1. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
2. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
3. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.

3.4 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.

3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

B. Embed drains in 8-inch-minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 6-inch- minimum concrete around bottom and sides.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.

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.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.8 STORMWATER INLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.9 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance with ACI 318.

3.10 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in 6-inch- minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in 6-inch- minimum concrete around bottom and sides.

3.11 CONNECTIONS

A. Connect nonpressure, gravity-slow drainage piping in building’s storm building drains specified in Section 22 14 13 “Facility Storm Drainage Piping.”

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.12 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8- inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.13 IDENTIFICATION

A. Materials and their installation are specified in Section 31 20 00 "Earth Moving." 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.

3.14 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. 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 in accordance with 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. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

      a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
      b. Option: Test plastic piping in accordance with ASTM F1417.

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.

3.15 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 33 42 00

SECTION 33 46 10 – STORMWATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnishing and Installing Stormwater Treatment Systems.

B. Related Requirements:
1. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 REFERENCES

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements are specified herein:
1. New York State Department of Transportation (NYSDOT) Standard Specifications, Construction and Materials, dated September 1, 2024, as amended.
2. New York State Department of Environmental Conservation (NYSDEC) Standards & Specifications for Erosion and Sediment Control (Blue Book)
3. NYSDEC Stormwater Management Design Manual and GP 0-25-001.
4. American National Standards Institute (ANSI)
5. American Society for Testing and Materials (ASTM)
6. Projects Stormwater Pollution Prevention Plan (SWPPP)

1.3 SUBMITTALS

A. Submittals shall be submitted in accordance with the provisions set forth in the General Specifications.
B. Submit laboratory test results for the organic matter, pH value, and gradation and other values stated. These tests will be performed and signed by a certified soils laboratory.
C. Submittal shall contain source and supplier of material showing its compliance with specifications and associated standards.

1. Samples of all materials requested shall be submitted to the Owner’s Representative.

2. Test results and certifications showing the Water Quality Unit meets the flow requirements and water quality volume treatment requirements. Contractor shall provide a detailed shop drawing of unit showing dimensions.
3. Installation instructions, shop drawings material certifications for all materials and individual components of the water quality Units.
4. Operations and maintenance manuals for the Water Quality Unit shall be supplied with testing certifications for review and approval by the Director's Representative.
5. Operating and Maintenance Manual for water quality units.

D. The Contractor shall submit schedules for the accomplishment of the work.

1.4 QUALITY ASSURANCE

A. Since all testing facilities calibrate their equipment differently all materials testing shall be performed by the same testing facility.

B. Contractor shall have representatives from the manufacture/supplier of the Water Quality Unit on site during at least the first day of installation to ensure installation is in accordance with the manufacturer's instructions/requirements.

C. Each soil type used on this project shall be tested and approved before placement. Secure approval before stripping soil from a borrow area or delivering soil to the project site.

PART 2 - PRODUCTS

2.1 WATER QUALITY UNIT - MATERIALS

A. Unless otherwise stated elsewhere in the Contract Drawings, the materials used to construct permanent stormwater Best Management Practices shall be as stated herein.

1. Hydrodynamic Unit #1 shall be provided by a manufacturer approved for use within NYS. Unit shall be capable of treating a 3.58 CFS water quality storm. The unit shall be capable of bypassing higher flows (at least an additional 16.59 CFS) or shall be placed offline. Precast concrete units, frames and covers shall meet the requirements of Section 33 42 00 and shall be HS20 rated and secured with tamper proof bolts. Metal components in the unit shall be either Type 316 or 316L stainless steel. Fiberglass components shall meet the national Bureau of Standards PS-15 and be coated with an isophthalic polyester gelcoat. Basis of Design: Hydro International.
2. Hydrodynamic Unit #2 shall be provided by a manufacturer approved for use within NYS. Unit shall be capable of treating a 0.55 CFS water quality storm. The unit shall be capable of bypassing higher flows (at least an additional 2.01

CFS) or shall be placed offline. Precast concrete units, frames and covers shall meet the requirements of Section 33 42 00 and shall be HS20 rated and secured with tamper proof bolts. Metal components in the unit shall be either Type 316 or 316L stainless steel. Fiberglass components shall meet the national Bureau of Standards PS-15 and be coated with an isophthalic polyester gelcoat. Basis of Design: Hydro International.

3. Hydrodynamic Unit #3 shall be provided by a manufacturer approved for use within NYS. Unit shall be capable of treating a 0.74 CFS water quality storm. The unit shall be capable of bypassing higher flows (at least an additional 1.98 CFS) or shall be placed offline. Precast concrete units, frames and covers shall meet the requirements of Section 33 42 00 and shall be HS20 rated and secured with tamper proof bolts. Metal components in the unit shall be either Type 316 or 316L stainless steel. Fiberglass components shall meet the national Bureau of Standards PS-15 and be coated with an isophthalic polyester gelcoat. Basis of Design: Hydro International.

2.2 BIORETENTION SOIL

A. Bioretention soil shall be a uniform mix, free from stones, stumps, roots or other similar objects larger than two inches. No other materials or substances shall be mixed or dumped with the bioretention area that may be harmful to plant growth or prove a hindrance to the planting or maintenance operations. The bioretention soil shall be free of noxious weeds. The soil shall meet the following criteria:

Sand	60-75%
Topsoil	25-40%
pH Range	5.2-7.0 (ASTM D2976)
Organic Matter	1.5-4.0% (ASTM 2974)
Magnesium	35 lb./ac. Min.
Phosphorus	P2O5 75 lb./ac. Max.
Potassium K2O	85 lb./ac. Min.
Soluble Salts	Not to exceed 500 ppm
Cation Exchange Capacity	(CEC) > 10
Permeability	0.5”/Hr (ASTM D2434, assume a relative compaction of 85% of modified max dry density (ASTM D1557)

If the pH is out of the acceptable range it may be modified with lime (to raise it) or Iron Sulfate plus sulfur (to lower) at the discretion of the Owner’s Representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Water Quality Unit:
   1. Water quality units shall be installed as per the manhole details on the plans, Section 33 42 00 and installation and as per the manufacturer's installation recommendations.
   2. Contractor shall modify pipe slopes and sizes and provide revised slopes and sizes based on system chosen. Contractor shall also provide any additional structures and pipes necessary to complete installation of system chosen and provide operational system. If system is placed offline then additional structures shall be used to divert the flow.
   3. Contractor shall clean Water Quality Unit when the project has reached substantial completion and the site has been stabilized.

3.2 BIORETENTION PREPARATION

A. Grub out and remove all vegetation in the area of the approved soil source.

B. Excavation equipment shall be positioned outside of the bioretention basin during excavation; no heavy equipment shall be allowed in the bottom of the basin.

C. Install Storm drainage pipe and structures prior to loosening the subgrade.

D. To ensure a proper bond with the Bioretention Soil, harrow or otherwise loosen the subgrade to a depth of 4 inches before spreading the Bioretention Soil. The Contractor shall take special care not to damage the storm drainage pipe and structures in the Bioretention Basin.

E. After the subgrade is loosened, conduct a percolation test in the presence of the Engineer/Landscape Architect.
   1. Bore four holes, 6 to 8 inches in diameter and 24 inches deep, in the bottom of the basin. Do not locate holes over buried storm drainage pipe.
   2. Scrape or roughen the sides of each hole. Remove all loose material from these holes.
   3. Place 2 inches of washed gravel at the bottom of each hole to reduce scoring when testing.
   4. Fill the holes up to the surface with water.
   5. Measure the drop of the water level in inches for each hole within the first hour of filling the holes. Take three additional measurements over the next three hours, recording the drop of water level in inches. The Contractor shall record these measurements in the field for each hole; measurements shall include the date and time the hole was initially filled with water, the time of the subsequent

measurements, and the drop in inches. Calculate the percolation rate for each hole by the drop in inches at four hours after filling the hole.

6. Should any bore hole test yield a percolation rate of less than 0.50 inches per hour, notify the Engineer/Landscape Architect prior to spreading the Bioretention Soil.

F. Excavation only can occur during dry weather and when the subgrade is not saturated or pooling water.

3.3 SPREADING BIORETENTION SOIL

A. Spread the Bioretention Soil in the Basin within 24 hours of reaching a successful percolation test rate. Protect the excavation with temporary fencing until the Bioretention Soil can be spread.

B. Place soil in 12-inch or lesser lifts taking care not to compact the soil. Final grade dry swale areas by hand; do not use heavy equipment.

C. Meet the grades and side slopes shown in the Engineer's Grading Plan. Ensure that the final grades and storm structure rim elevations are correct before beginning plant installation.

D. Perform soil spreading operations only during dry weather. Do not place or work Bioretention Soils when they are wet or frozen.

3.4 BIORETENTION PROTECTION

A. Protect bioretention basins with temporary fencing after the Bioretention Soil has been placed until the commencement of planting the basin. Keep the basin free of trash and debris.

END OF SECTION 33 46 10

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