BALTIMORE CITY
PUBLIC SCHOOLS

HOLABIRD ELEMENTARY AND MIDDLE SCHOOL

BALTIMORE, MARYLAND

BALTIMORE CITY PUBLIC SCHOOLS

BID SET

VOLUME 2 OF 2
DIVISIONS 21 - 33

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G+P
GRIMM AND PARKER

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TABLE OF CONTENTS

VOLUME 1

DIVISION 01 - GENERAL REQUIREMENTS

DIVISION 02 - EXISTING CONDITIONS

DIVISION 03 - CONCRETE

DIVISION 04 - MASONRY

DIVISION 05 - METALS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 08 - OPENINGS

DIVISION 12 - FURNISHINGS

DIVISION 14 - CONVEYING EQUIPMENT

VOLUME 2

DIVISION 21 - FIRE PROTECTION

DIVISION 22 - PLUMBING

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

DIVISION 26 - ELECTRICAL

END OF TABLE OF CONTENTS

SECTION 21 05 13 - COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

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

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

2.3 POLYPHASE MOTORS

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

B. Efficiency: Energy 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. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. 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.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and 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.

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

2.5 SINGLE-PHASE MOTORS

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

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

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

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

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

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

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

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

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

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

2.4 SLEEVE-SEAL FITTINGS

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

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

2.5 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

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

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

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Sheet Metal Flashing and Trim.
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Penetration Firestopping.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

2.2 FLOOR PLATES

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

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

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. General requirements for valves.
2. Two-piece ball valves with indicators.
3. Bronze butterfly valves with indicators.
4. Iron butterfly valves with indicators.
5. Check valves.
6. Bronze OS&Y gate valves.
7. Iron OS&Y gate valves.
8. NRS gate valves.
9. Indicator posts.
10. Trim and drain valves.

1.3 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

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 operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

1. Main Level: HAMV - Fire Main Equipment.
    a. Level 1: HCBZ - Indicator Posts, Gate Valve.
    b. Level 1: HLOT - Valves.
        1) Level 3: HLUG - Ball Valves, System Control.
        2) Level 3: HLXS - Butterfly Valves.
        3) Level 3: HMER - Check Valves.
        4) Level 3: HMRZ - Gate Valves.
2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
    a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
1. Automated Sprinkler Systems:
    a. Indicator posts.
    b. Valves.
        1) Gate valves.
        2) Check valves.
            a) Single check valves.
        3) Miscellaneous valves.

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

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

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

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

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

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

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

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. American Valve, Inc.
2. Conbraco Industries, Inc.; Apollo Valves.
3. NIBCO INC

B. Description:
1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.

7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear or traveling nut.
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

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:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. NIBCO INC

B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

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:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. NIBCO INC

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.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer.

2.5 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. NIBCO INC

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.
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.

2.6 BRONZE OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO 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: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO 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.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.8 NRS GATE VALVES

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

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO 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 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.

2.9 INDICATOR POSTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO INC

B. Description:
1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Wall.
3. Base Barrel Material: Cast or ductile iron PVC.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Wrench Handwheel.

2.10 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO INC
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, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. NIBCO 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, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. NIBCO INC
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 EXAMINATION

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

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

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

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

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

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

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

1. "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
2. "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.

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

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

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

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

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

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

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

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

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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.

D. Valve Schedules: Valve numbering scheme.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
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 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. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel 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.

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

2.2 WARNING SIGNS AND LABELS

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

B. Letter Color: Red.

C. Background Color: White.

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

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

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

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

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

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

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

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

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

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inches high.

E. Pipe-Label Colors:

1. Background Color: Red.
2. Letter Color: White.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Aluminum.
   2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
   2. Fasteners: Brass wire-link chain.
   3. Valve-Tag Color: Red.
   4. Letter Color: White.

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

2.6 WARNING TAGS

A. 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: Safety Yellow background with black lettering.

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 LABEL INSTALLATION

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 equipment labels where accessible and visible.

E. Piping Color-Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

F. Stenciled Pipe-Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

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

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
   1. Valve-Tag Size and Shape:
      a. Fire-Suppression Standpipe: 1-1/2 inches, round.
      b. Wet-Pipe Sprinkler System: 1-1/2 inches, round.
      c. Clean-Agent Fire-Extinguishing System: 1-1/2 inches, round.

3.4 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 21 11 19 - FIRE-DEPARTMENT CONNECTIONS

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. Exposed-type fire-department connections.
   2. Flush-type fire-department connections.
   3. Yard-type fire-department connections.

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 fire-department connection.

PART 2 - PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. American Fire Hose & Cabinet.
   2. Elkhart Brass Mfg. Co., Inc.
   3. Fire Protection Products, Inc.
   4. Fire-End & Croker Corporation.
   5. GMR International Equipment Corporation.
   6. Guardian Fire Equipment, Inc.
   7. Venus Fire Protection Ltd.
   8. Wilson & Cousins Inc.

B. Standard: UL 405.

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

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

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

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

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

I. Outlet: Back, with pipe threads.

J. Number of Inlets: Two.

K. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE"

L. Finish: Polished chrome plated.

M. Outlet Size: NPS 4.

2.2 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. American Fire Hose & Cabinet.
   2. Elkhart Brass Mfg. Co., Inc.
   3. GMR International Equipment Corporation.
   4. Guardian Fire Equipment, Inc.
   5. Potter Roemer LLC.
   6. Venus Fire Protection Ltd.

B. Standard: UL 405.

C. Type: Flush, for wall mounting.

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

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

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

H. Escutcheon Plate: Rectangular, brass, wall type.

I. Outlet: With pipe threads.

J. Body Style: Horizontal.

K. Number of Inlets: Two.

L. Outlet Location: Back.

M. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE"

N. Finish: Polished chrome plated.

O. Outlet Size: NPS 4.

2.3 YARD-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Elkhart Brass Mfg. Co., Inc.
   2. Fire Protection Products, Inc.
   3. Fire-End & Croker Corporation.
   4. GMR International Equipment Corporation.
   5. Guardian Fire Equipment, Inc.
   6. Potter Roemer LLC.
   7. Wilson & Cousins Inc.

B. Standard: UL 405.

C. Type: Exposed, freestanding.

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

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

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

H. Escutcheon Plate: Round, brass, floor type.

I. Outlet: Bottom, with pipe threads.

J. Number of Inlets: Two.

K. Sleeve: Brass.

L. Sleeve Height: 18 inches.

M. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE"

N. Finish, Including Sleeve: Polished chrome plated.

O. Outlet Size: NPS 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.

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

3.2 INSTALLATION

A. Install wall-type fire-department connections.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."

C. Install two protective pipe bollards on sides of each fire-department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."

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

END OF SECTION

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Requirements:
1. Section 21 12 00 "Fire-Suppression Standpipes" for standpipe piping.
2. Section 21 31 13 "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and fire-pump controllers.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTIONS

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

1.5 PERFORMANCE REQUIREMENTS

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

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Available fire-hydrant flow test records indicate the following conditions:
a. Date:
b. Time:
c. Performed by:
d. Location of Residual Fire Hydrant R:
e. Location of Flow Fire Hydrant F:
f. Static Pressure at Residual Fire Hydrant R:
g. Measured Flow at Flow Fire Hydrant F:
h. Residual Pressure at Residual Fire Hydrant R:

C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications:
   a. Building Service Areas: Ordinary Hazard, Group 1.
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. General Storage Areas: Ordinary Hazard, Group 1.
   d. Laundries: Ordinary Hazard, Group 1.
   e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   f. Residents, Office, and Public Areas: Light Hazard.
3. Maximum Protection Area per Sprinkler:
   a. Residential and Office Spaces: 225 sq. ft.
   b. Storage Areas: 130 sq. ft.
   c. Mechanical Equipment Rooms: 130 sq. ft.
   d. Electrical Equipment Rooms: 130 sq. ft.
   e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

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

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

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

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Domestic water piping.
   2. HVAC hydronic piping.
   3. Items penetrating finished ceiling include the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Electrical Conduit.
   4. Natural Gas Piping.

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

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

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

J. Field quality-control reports.

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

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

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

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

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

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

C. Galvanized and Uncoated,Steel Couplings: ASTM A 865, threaded.

D. Galvanized [and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

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

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

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

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

I. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
   2. Pressure Rating: 175-psig minimum.
   3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

J. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Victaulic Company.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

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.

2.4 COVER SYSTEM FOR SPRINKLER PIPING

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

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

C. Brackets: Glass-reinforced nylon.

2.5 LISTED FIRE-PROTECTION VALVES

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

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Victaulic Company.
   2. Standard: UL 1091 except with ball instead of disc.

3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fivalco Inc.
b. Global Safety Products, Inc.
c. Milwaukee Valve Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International, Inc.
b. Global Safety Products, Inc.
c. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Cast or ductile iron.
5. Style: Lug or wafer.
6. End Connections: Grooved.

E. Check Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AFAC Inc.
b. Victaulic Company.
c. Viking Corporation.
2. Standard: UL 312.
3. Pressure Rating: 250 psig minimum.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.

5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Clow Valve Company; a division of McWane, Inc.
2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International, Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig minimum.
4. Valves NPS 2 and Smaller:
a. Valve Type: Ball or butterfly.
b. Body Material: Bronze.
c. End Connections: Threaded.
5. Valves NPS 2-1/2 and Larger:
a. Valve Type: Butterfly.
b. Body Material: Cast or ductile iron.
c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

I. NRS Gate Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Tyco Fire & Building Products LP.
2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Cast iron with indicator post flange.
5. Stem: Nonrising.
6. End Connections: Flanged or grooved.

J. Indicator Posts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.

c. Tyco Fire & Building Products LP.
2. Standard: UL 789.
3. Type: Horizontal for wall mounting.
4. Body Material: Cast iron with extension rod and locking device.
5. Operation: Wrench.

2.6 TRIM AND DRAIN VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

B. Angle Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fire Protection Products, Inc.
b. United Brass Works, Inc.

C. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Affiliated Distributors.
b. Anvil International, Inc.
c. Victaulic Company.

D. Globe Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fire Protection Products, Inc.
b. United Brass Works, Inc.

E. Plug Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Southern Manufacturing Group.

2.7 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
b. High-Pressure Piping Specialty Valves: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.
   c. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFAC Inc.
   b. Reliable Automatic Sprinkler Co., Inc.
   c. Tyco Fire & Building Products LP.
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.

2.8 FIRE-DEPARTMENT CONNECTIONS

A. Fire-Department Connection:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFAC Inc.
   b. Wilson & Cousins Inc.
2. Standard: UL 405.
3. Type: Exposed, freestanding.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: Two.
11. Sleeve: Brass.
12. Sleeve Height: 18 inches.
13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
14. Finish, Including Sleeve: Polished chrome plated.
15. Outlet Size: NPS 4.

2.9 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Anvil International, Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Elkhart Brass Mfg. Company, Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AGF Manufacturing Inc.
   b. Victaulic Company.
   c. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide."
3. Pressure Rating: 175-psig minimum.

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

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. CECA, LLC.
b. Corcoran Piping System Co.
c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250-psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fivalco Inc.
b. FlexHead Industries, Inc.
c. Gateway Tubing, Inc.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.10 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Reliable Automatic Sprinkler Co., Inc.
2. Victaulic Company.
3. Viking Corporation.

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

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

D. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
1. Characteristics:
a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.

E. Sprinkler Finishes:

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

F. Special Coatings:
1. Wax.
2. Lead.
3. Corrosion-resistant paint.

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.11 ALARM DEVICES

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

B. Water-Motor-Operated Alarm:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Globe Fire Sprinkler Corporation.
b. Victaulic Company.
c. Viking Corporation.
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
8. Outlet: NPS 1drain connection.

C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum- diameter.

5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ADT Security Services, Inc.
b. Viking Corporation.
c. Watts Industries (Canada) Inc.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AFAC Inc.
b. United Electric Controls Co.
c. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AFAC Inc.
b. United Electric Controls Co.
c. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Potter Electric Signal Company.
b. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.12 MANUAL CONTROL STATIONS

A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.13 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
   1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
   3. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.14 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AMETEK; U.S. Gauge Division.
   2. Ashcroft, Inc.
   3. Brecco Corporation.

B. Standard: UL 393.

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

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

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

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

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 for installation of sprinkler piping in NFPA 13.

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

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

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

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

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

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

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

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

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

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

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

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

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

M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

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

3.5 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

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

3.6 VALVE AND SPECIALTIES INSTALLATION

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

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

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

D. Specialty Valves:

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

3.7 SPRINKLER INSTALLATION

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

3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."
   1. Install two protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."

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

3.9 IDENTIFICATION

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

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

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

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

D. Prepare test and inspection reports.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.12 DEMONSTRATION

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

3.13 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 or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

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

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or, 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. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.14 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: In common areas Pendent sprinklers.
   3. Wall Mounting: Sidewall sprinklers.
   4. Spaces Subject to Freezing: Pendent, dry sprinklers.
   5. Residential units: Concealed sprinklers with white cover plates.

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.

END OF SECTION

SECTION 21 31 13 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Split-case fire pumps.
   2. Fire-pump accessories and specialties.
   3. Flowmeter systems.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

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

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each fire pump, from manufacturer.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

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

B. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

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

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

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

2.2 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. A-C Fire Pump Systems; a business of ITT Industries.
2. Corcoran Piping System Co.
3. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
4. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
5. Peerless Pump, Inc.
6. Pentair Pump Group; Aurora Pump.
7. Reddy-Buffaloes Pump Company.
8. Ruhrpumpen, Inc.
9. S.A. Armstrong Limited.
10. Aurora Pumps.

B. Pump:
1. Standard: UL 448, for split-case pumps for fire service.
2. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.
   a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
   b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

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

E. Capacities and Characteristics:
1. Rated Capacity: 750 gpm.
2. Total Rated Head: 90 psi.
3. Inlet Flange: Class 125.

4. Outlet Flange: Class 125.
5. Suction Head Available at Pump: 63 psi.
6. Motor Horsepower: 60 HP.
7. Motor Speed: 2950 rpm.
8. Electrical Characteristics:
    a. Volts: 208.
    b. Phase: Three.
    c. Hertz: 60.
    d. Full-Load Amperes: 177.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

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

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

C. Relief Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. BERMAD Control Valves.
    b. CLA-VAL Automatic Control Valves.
    c. Kunkle Valve; a part of Tyco International Ltd.
    d. OCV Control Valves.
    e. Watts Regulator Company; a division of Watts Water Technologies, Inc.
    f. Zurn Plumbing Products Group; Wilkins Water Control Products.
2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

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

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

F. Discharge Cone: Closed or open type.

G. Hose Valve Manifold Assembly:
1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.
5. Manifold:
    a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
    b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
    c. Escutcheon Plate: Brass or bronze; round.
    d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
    e. Exposed Parts Finish: chrome plated.
    f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

2.5 SOURCE QUALITY CONTROL

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

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

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

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

3.2 INSTALLATION

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

B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

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

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

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 21 12 00 "Fire-Suppression Standpipes."

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Section 21 12 00 "Fire-Suppression Standpipes."

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

H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.

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

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

3.3 ALIGNMENT

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

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

C. Align piping connections.

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

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 21 12 00 "Fire-Suppression Standpipes." Drawings indicate general arrangement of piping, fittings, and specialties.

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

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

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

E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

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

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 21 39 00 "Controllers for Fire-Pump Drivers."

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

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

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

F. Prepare test and inspection reports.

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

3.7 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.

3.8 DEMONSTRATION

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

END OF SECTION

SECTION 21 34 00 - PRESSURE-MAINTENANCE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Multistage, pressure-maintenance pumps.
   2. Regenerative-turbine, pressure-maintenance pumps.
   3. Submersible, pressure-maintenance pumps.
   4. Vertical-turbine, pressure-maintenance pumps.

B. Related Section:
   1. Controllers for Fire-Pump Drivers for pressure-maintenance-pump controllers.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For pumps, accessories, and specialties. 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.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

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

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 VERTICAL-TURBINE, PRESSURE-MAINTENANCE PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. A-C Fire Pump Systems; a business of ITT Industries.

2. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
3. Peerless Pump, Inc.
4. Pentair Pump Group; Aurora Pump.
5. Pentair Pump Group; Fairbanks Morse.
6. Reddy-Buffaloes Pump Company.
7. Ruhrpumpen, Inc.
8. S.A. Armstrong Limited.
9. Sulzer Pumps Ltd.
10. Weir Floway; a company of Weir Clear Liquid.

B. Description: Factory-assembled and -tested, vertical, multistage, open-line-shaft turbine pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.

C. Pump Construction:
1. Pump Head: Cast iron, for surface discharge, with flange except connections may be threaded in sizes in which flanges are not available.
2. Pump Head Seal: Stuffing box and stuffing.
3. Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
4. Line Shaft Bearings: Rubber sleeve, water lubricated.
5. Line Shaft: Steel.
6. Line Shaft Bearings: Corrosion resistant, oil lubricated.
7. Impeller Shaft: Monel metal or stainless steel.
8. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
9. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet or less, with strainer of cast or fabricated bronze or stainless steel at bottom.

D. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Common Motor Requirements for Fire Suppression Equipment.
1. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet long.

E. Base: Cast iron or steel with hole for electrical cable.

F. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

G. Capacities and Characteristics:
1. Rated Capacity: 24 gpm.
2. Total Dynamic Head: 100 psi.
3. Flange: Class 125.
4. Suction Head Available at Pump: 55 psi.
5. Motor Horsepower: 5 HP.
6. Motor Speed: 3500 rpm.
7. Electrical Characteristics:
a. Volts: 120.
b. Phases: Three.
c. Hertz: 60.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Common Motor Requirements for Fire Suppression 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 EQUIPMENT INSTALLATION

A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.

B. Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Cast-in-Place Concrete.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Attach pumps to equipment base using anchor bolts.

C. Install vertical-turbine, pressure-maintenance pumps according to HI 2.4.

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. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. 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. Replace damaged and malfunctioning controls and equipment.

D. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 ADJUSTING

A. Lubricate pumps as recommended by manufacturer.

B. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION

SECTION 21 39 00 - CONTROLLERS FOR FIRE-PUMP DRIVERS

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. Full-service, reduced-voltage controllers rated 600 V and less.
2. Limited-service controllers rated 600 V and less.
3. Controllers for diesel-drive fire pumps.
4. Controllers for pressure-maintenance pumps.
5. Remote alarm panels.
6. Low-suction-shutdown panels.

1.3 DEFINITIONS

A. ATS: Automatic transfer switch(es).

B. ECM: Electronic control module.

C. MCCB: Molded-case circuit breaker.

D. N.O.: Normally open.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories**.**

B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
1. Show tabulations of the following:
a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA 250, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of integrated unit.
f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
g. Specified modifications.
2. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
3. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of product indicated, from manufacturer.

D. Manufacturer's factory test reports of fully assembled and tested equipment.

E. Source quality-control reports.

F. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Operation and Maintenance Data, include the following:
   1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

1.8 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. Indicating Lights: Two of each type and color of lens installed; two of each type and size of lamp installed.
   2. Auxiliary Contacts: One for each size and type of magnetic contactor installed.
   3. Power Contacts: Three for each size and type of magnetic contactor installed.
   4. Contactor Coils: One for each size and type of magnetic controller installed.
   5. Relay Boards: One for each size and type of relay board installed.
   6. Operator Interface: One microprocessor board(s), complete with display and membrane keypad.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

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

D. Comply with standards of authorities having jurisdiction pertaining to materials and installation.

E. Comply with NFPA 20 and NFPA 70.

F. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Vibration and Seismic Controls for Electrical Systems.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, protect controllers from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller connect factory-installed space heaters to temporary electrical service.

1.11 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Ambient Temperature Rating: Not less than 40 deg F and not exceeding 122 deg F unless otherwise indicated.
   2. Altitude Rating: Not exceeding 6600 feet unless otherwise indicated.

B. Interruption of Existing Electric Service: Notify Architect no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

1.12 COORDINATION

A. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

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

PART 2 - PRODUCTS

2.1 FULL-SERVICE CONTROLLERS

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. Aquarius Fluid Products, Inc.
   2. ASCO Power Technologies, LP; Firetrol Products.
   3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Hubbell Incorporated; Hubbell Industrial Controls.
   5. Joslyn Clark Corporation.
   6. Master Control Systems, Inc.
   7. Metron, Inc.
   8. Tornatech.

B. General Requirements for Full-Service Controllers:
   1. Comply with NFPA 20 and UL 218.
   2. Listed by an NRTL for electric-motor driver for fire-pump service.
   3. Combined automatic and nonautomatic operation.
   4. Factory assembled, wired, and tested; continuous-duty rated.
   5. Service Equipment Label: NRTL labeled for use as service equipment.

C. Method of Starting:
   1. Pressure-switch actuated.
      a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      b. System pressure recorder, electric ac driven, with spring backup.
      c. Programmable minimum-run-time relay to prevent short cycling.

d. Programmable timer for weekly tests.
2. Magnetic Controller: Across-the-line type.
3. Solid-State Controller: Reduced-voltage type.
4. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Automatic and non-automatic shutdown after automatic starting.

E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and non-thermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

G. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.
3. Local and Remote Alarm and Status Indications:
a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.
e. Line-power single-phase condition.
4. Audible alarm, with silence push button.
5. Non-automatic START and STOP push buttons or switches.

H. Optional Features:
1. Extra Output Contacts:
a. One N.O. contact(s) for motor running condition.
b. One set(s) of contacts for loss-of-line power.
c. One each, Form C contacts for high and low reservoir level.
2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

I. ATS:
1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with non-thermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
7. Local and Remote Alarm and Status Indications:

a. Normal source available.
b. Alternate source available.
c. In normal position.
d. In alternate position.
e. Isolating means open.

8. Audible alarm, with silence push button.
9. Non-automatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

2.2 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Metron, Inc.
8. Tornatech.

B. General Requirements for Pressure-Maintenance-Pump Controllers:
1. Type: UL 508 factory assembled, -wired, and tested, across-the-line; for combined automatic and manual operation.
2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
3. Factory assembled, wired, and tested.
4. Finish: Manufacturer's standard color paint.

C. Rate controller for scheduled horsepower and include the following:
1. Fusible disconnect switch.
2. Pressure switch.
3. Hand-off-auto selector switch.
4. Pilot light.
5. Running period timer.

2.3 REMOTE ALARM PANELS

A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.

B. 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. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Metron, Inc.
8. Tornatech.

C. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.

D. Supervisory and Normal Control Voltage: 120-V ac; single source.

E. Audible and Visual Alarm and Status Indications:
   1. Driver running.
   2. Loss of phase.
   3. Phase reversal.
   4. Supervised power on.

F. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; push-to-test.
   1. Engine running.
   2. Controller main switch turned to the off or manual position.
   3. Supervised power on.
   4. Common trouble on the controller or engine.
   5. Common pump room trouble.
   6. Controller connected to alternate power source.

G. Audible alarm, with silence push button.

H. Pump REMOTE START push button.

2.4 LOW-SUCTION-SHUTDOWN PANELS

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. Aquarius Fluid Products, Inc.
   2. ASCO Power Technologies, LP; Firetrol Products.
   3. Hubbell Incorporated; Hubbell Industrial Controls.
   4. Joslyn Clark Corporation.
   5. Master Control Systems, Inc.
   6. Metron, Inc.
   7. Tornatech.

B. General Requirements for Low-Suction-Shutdown Panels:
   1. Listed by an NRTL for fire-pump service.
   2. Factory assembled, wired, and tested.
   3. Prevents automatic start of fire pump, and shuts down automatically started fire pump, on low-suction pressure.
   4. Automatic reset.

C. Operation: External contact input.

D. Supervisory and Normal Control Voltage: 120-V ac; single source.

E. Include audible and visual alarms and status indications, with silence push button, for the following conditions:
   1. Control power available.
   2. Low-suction pressure.
   3. Normal-suction pressure.

2.5 ENCLOSURES

A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
   1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
   2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
   3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.
   1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

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

3.2 CONTROLLER INSTALLATION

A. Install controllers within sight of their respective drivers.

B. Connect controllers to their dedicated pressure-sensing lines.

C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Hangers and Supports for Electrical Systems.

D. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Cast-in-Place Concrete.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Seismic Bracing: Comply with requirements specified in Vibration and Seismic Controls for Electrical Systems.

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Comply with NEMA ICS 15.

3.3 REMOTE ALARM AND LOW-SUCTION-SHUTDOWN PANEL INSTALLATION

A. Install panels on walls with tops not higher than 72 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Hangers and Supports for Electrical Systems.

3.4 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Low-Voltage Electrical Power Conductors and Cables.

3.5 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Control-Voltage Electrical Power Cables.

B. Install wiring between remote alarm and low-suction-shutdown panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Control-Voltage Electrical Power Cables.

C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Digital, Addressable Fire-Alarm System.

D. Bundle, train, and support wiring in enclosures.

E. Connect remote manual and automatic activation devices where applicable.

3.6 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Identification for Electrical Systems.

3.7 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:
   1. Inspect and Test Each Component:
      a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
      b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
      c. Test continuity of each circuit.
   2. Verify and Test Each Electric-Driver Controller:
      a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Architect before starting the motor(s).
      b. Test each motor for proper phase rotation.

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.

E. Field Acceptance Tests:
1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Architect and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

F. Controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

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 controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.10 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels.

END OF SECTION

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

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

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

2.3 POLYPHASE MOTORS

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

B. Efficiency: Energy 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. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. 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.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and 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.

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

2.5 SINGLE-PHASE MOTORS

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

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

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

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

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

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

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. 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. Smith, Jay R. Mfg. Co.
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.

3. Metraflex Company (The).

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

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

2.5 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

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

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

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Sheet Metal Flashing and Trim.
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Penetration Firestopping.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 CUTTING AND PATCHING

A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

3.5 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

END OF SECTION

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

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

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

2.2 FLOOR PLATES

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

2. Escutcheons for Existing Piping:
a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
i. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

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

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

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
7. Test-plug kits.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.

D. Dial: Non-reflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ashcroft Inc.
      b. Marsh Bellofram.
      c. Miljoco Corporation.
   2. Standard: ASME B40.200.
   3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
   4. Element: Bourdon tube or other type of pressure element.
   5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
   6. Dial: Non--reflective aluminum with permanently etched scale markings graduated in deg F.
   7. Pointer: Dark-colored metal.
   8. Window: Glass.
   9. Ring: Metal.
   10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
   11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   12. Accuracy: Plus or minus 1 percent of scale range.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AMETEK, Inc.; U.S. Gauge.
      b. Ashcroft Inc.
      c. Marsh Bellofram.
   2. Standard: ASME B40.200.
   3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
   4. Element: Bourdon tube or other type of pressure element.
   5. Movement: Mechanical, with link to pressure element and connection to pointer.
   6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
   7. Pointer: Dark-colored metal.
   8. Window: Glass.
   9. Ring: Metal.
   10. Connector Type(s): Union joint, back; with ASME B1.1 screw threads.
   11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

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

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

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Flo Fab Inc.
   b. Miljoco Corporation.
   c. Palmer Wahl Instrumentation Group.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of Grade B, plus or minus 2 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AMETEK, Inc.; U.S. Gauge.
b. Ashcroft Inc.
c. Ernst Flow Industries.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

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

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

2.6 TEST PLUGS

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. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.7 TEST-PLUG KITS

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. Flow Design, Inc.
2. Miljoco Corporation.

3. National Meter, Inc.

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. 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.

C. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

D. Install remote-mounted pressure gages on panel.

E. Install valve and snubber in piping for each pressure gage for fluids.

F. Install test plugs in piping tees.

G. 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.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCHEDULE

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

B. 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. Direct-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.

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

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

3.5 THERMOMETER SCALE-RANGE SCHEDULE

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

B. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F.

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

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building 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 chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. 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 chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. 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 chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

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

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron ball valves.
5. Iron, single-flange butterfly valves.
6. Iron, grooved-end butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron swing check valves with closure control.
11. Iron, grooved-end swing check valves.
12. Iron, center-guided check valves.
13. Iron, plate-type check valves.
14. Bronze gate valves.
15. Iron gate valves.
16. Bronze globe valves.
17. Iron globe valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 and smaller.

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

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Hammond Valve.
      b. Milwaukee Valve Company.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 200 psig.

c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Bronze Angle Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Valve, Inc.
b. NIBCO INC.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. DynaQuip Controls.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

B. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Valve, Inc.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.5 IRON BALL VALVES

A. Class 125, Iron Ball Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Valve, Inc.
b. Sure Flow Equipment Inc.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.6 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

2.7 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Kennedy Valve; a division of McWane, Inc.
   b. Tyco Fire Products LP; Grinnell Mechanical Products.
   c. Victaulic Company.
2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 175 psig.
   c. Body Material: Coated, ductile iron.
   d. Stem: Two-piece stainless steel.
   e. Disc: Coated, ductile iron.
   f. Seal: EPDM.

2.8 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

B. Class 125, Lift Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Flo Fab Inc.
b. Hammond Valve.
c. Kitz Corporation.

2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: NBR, PTFE, or TFE.

2.9 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.10 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-71, Type I.

b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE or TFE.
j. Gasket: Asbestos free.

2.11 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. NIBCO INC.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig .
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and spring.

2.12 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.
2. Description:
a. CWP Rating: 300 psig.

b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring-operated, ductile iron or stainless steel.

2.13 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International, Inc.
b. APCO Willamette Valve and Primer Corporation.
c. Crispin Valve.
d. DFT Inc.
e. Flo Fab Inc.
f. GA Industries, Inc.
g. Hammond Valve.
h. Metraflex, Inc.
i. Milwaukee Valve Company.
j. Mueller Steam Specialty; a division of SPX Corporation.
k. NIBCO INC.
l. Spence Strainers International; a division of CIRCOR International, Inc.
m. Sure Flow Equipment Inc.
n. Val-Matic Valve & Manufacturing Corp.
o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-125.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron.
d. Style: Compact wafer.
e. Seat: Bronze.

2.14 IRON, PLATE-TYPE CHECK VALVES

A. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. APCO Willamette Valve and Primer Corporation.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Flomatic Corporation.
d. Mueller Steam Specialty; a division of SPX Corporation.
2. Description:
a. Standard: API 594.
b. CWP Rating: 200 psig.
c. Body Design: Wafer, spring-loaded plates.
d. Body Material: ASTM A 126, gray iron.
e. Seat: Bronze.

2.15 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

2.16 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Milwaukee Valve Company.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

2.17 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Powell Valves.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   j. Zy-Tech Global Industries, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

2.18 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.

h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Zy-Tech Global Industries, Inc.

2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

E. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball, butterfly, or gate valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Pump-Discharge Check Valves:
a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

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

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

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, full port, brass or bronze with brass] trim.
4. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.
5. Bronze Gate Valves: Class 125, NRS.

B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Grooved-End Butterfly Valves: 175 CWP.
4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
5. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
6. Iron, Grooved-End Swing Check Valves: 300 CWP.
7. Iron, Center-Guided Check Valves: Class 125, metal seat.
8. Iron Gate Valves: Class 125, OS&Y.

3.6 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

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

B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves: Class 150.
3. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.

4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
5. Iron, Grooved-End Swing Check Valves: 300 CWP.
6. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Miscellaneous materials.
9. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   3. Standard: MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

7. Metallic Coating: Electroplated zinc or Hot-dipped galvanized.
8. Paint Coating: Vinyl.
9. Plastic Coating: PVC.
10. Combination Coating: Insert coating materials in order of application.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International; a subsidiary of Mueller Water Products Inc.
b. Empire Industries, Inc.
c. ERICO International Corporation.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

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. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig 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, zinc-coated stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Stainless steel.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: One or more; plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.7 PIPE POSITIONING SYSTEMS

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

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

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

F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

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

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

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

J. 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.

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

L. 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.

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

N. 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.

O. Insulated Piping:
1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

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

3.4 ADJUSTING

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

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

3.5 PAINTING

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Exterior Painting.

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

F. Use stainless-steel pipe hangers and attachments for hostile environment applications.

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

H. Use padded hangers for piping that is subject to scratching.

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

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   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 might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

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

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

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

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

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

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

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

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

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

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

B. 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: Brass, 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. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel 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), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), 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: Black.

C. Background Color: White.

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

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

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

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

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

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

2.3 PIPE LABELS

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

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

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

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

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Aluminum.
   2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd 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; or S-hook.

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

2.6 WARNING TAGS

A. 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 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 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.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Domestic Water Piping
      a. Background: Blue.
      b. Letter Colors: Black.
   2. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Green.
      b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
   2. Valve-Tag Colors:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
   3. Letter Colors:
      a. Cold Water: Black.
      b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
   2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies 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. 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.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
   1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
   2. Jacket Materials for Pipe: 12 inches long by NPS 2.
   3. Sheet Jacket Materials: 12 inches square.
   4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation

materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

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

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
   1. Piping Mockups:
      a. One 10-foot section of NPS 2 straight pipe.
      b. One each of a 90-degree threaded, welded, and flanged elbow.
      c. One each of a threaded, welded, and flanged tee fitting.
      d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
      e. Four support hangers including hanger shield and insert.
      f. One threaded strainer and one flanged strainer with removable portion of insulation.
      g. One threaded reducer and one welded reducer.
      h. One pressure temperature tap.
      i. One mechanical coupling.
   2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
   3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   4. Obtain Architect's approval of mockups before starting insulation application.
   5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   7. Demolish and remove mockups when directed.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

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

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pittsburgh Corning Corporation; Foamglas.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
   6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

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

I. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
   2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Phenolic:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Kingspan Tarec Industrial Insulation NV; Koolphen K.
      b. Resolco International BV; Insul-phen.
   2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
   3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
   4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   5. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armacell LLC; Tubolit.
      b. Nomaco Insulation; IMCOLOCK and NOMALOCK.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers 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.
   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."

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96.
      b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-33.

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."

F. 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, but are not limited to, 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; 85-20.
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."

G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 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, but are not limited to, 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 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 indoor use on below-ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
b. Eagle Bridges - Marathon Industries; 501.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, 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 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, 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.
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 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass and Phenolic Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F.
   5. Color: White or gray.
   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. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   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."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.
   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 C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto Corporation; LoSmoke.
   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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Sheet and roll stock ready for shop or field sizing.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Pittsburgh Corning Corporation; Pittwrap.
   b. Polyguard Products, Inc.; Insulrap No Torch 125.

2.11 TAPES

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, 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.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
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.

2.12 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. C & F Wire.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Truebro; a brand of IPS Corporation.
   b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
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 EXAMINATION

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

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

3.2 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

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

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

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

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

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

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

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

1. Comply with requirements in 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 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 CELLULAR-GLASS INSULATION

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

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

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

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

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

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches 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.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

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

C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Seal split-tube 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 polyolefin sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   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.

3.11 FIELD-APPLIED JACKET INSTALLATION

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

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

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Exterior Painting and 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. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

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

3.13 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

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

3.14 PIPING INSULATION SCHEDULE, GENERAL

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

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

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 and Smaller: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 1/2 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
      d. Phenolic: 1 inch thick.
      e. Polyolefin: 1/2 inch thick.
   2. NPS 1-1/4 and Larger: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 3/4 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 3/4 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 1 inch thick.

C. Stormwater and Overflow:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 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 be one of the following:
a. Flexible Elastomeric: 3/4 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
c. Polyolefin: 3/4 inch.

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. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 3/4 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 3/4 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 22 08 00 - COMMISSIONING PLUMBING EQUIPMENT

1. GENERAL

   A. RELATED WORK

      1. Division 23 – HVAC

      2. Division 26 - Electrical

   B. REFERENCES

      1. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

      2. ASHRAE Guideline 1-1996

      3. ASHRAE Guideline 0-2005

      4. ACG Commissioning Guideline – 2005

   B. DESCRIPTION OF WORK

      1. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

      2. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

2. PRODUCTS

   A. Not used.

3. EXECUTION

A. ROLES OF THE COMMISSIONING AGENCY

1. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of Plumbing systems within the facility.

2. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

3. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

4. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

5. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

6. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

7. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

8. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for Plumbing systems and subsystems.

9. The CA will review operating and maintenance materials for Plumbing systems.

10. The CA will review phasing plans as provided by the CM relating to temporary use of Plumbing equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

B. SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

1. Domestic Hot Water
2. Automatic Flush Values

All ductwork testing shall be monitored by the commissioning/owner/CM

C. PLUMBING COMMISSIONING PLAN

1. Commissioning Team

a. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

Program Manager (PrM)
Facilities Management Division (FMD)
Commissioning Agent (CA)
Design Team (DT)
Construction Manager (CM)
Mechanical Contractor (MC)
Plumbing Contractor (PC)
Controls Contractor (CC)
Test and Balance Contractor (TABC)
Electrical Contractor (EC)

2. Basis of Design Document

a. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
b. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

3. Commissioning Meetings

a. Commissioning meetings will be held in conjunction with progress meetings as necessary. The CA will be on site for the CX meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

4. Resolution Tracking Forms (RTF)

a. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
b. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

5. System Verification Checklists (SVC) / Manufacturers' Checklists

a. The MC/PC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS*. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
b. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
c. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

6. Start-Up

a. Start-up of major Plumbing systems will be witnessed the CA. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Plumbing equipment.

b. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

7. Functional Performance Tests (FPT)
   a. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS* above.
   b. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
   c. The Functional Performance Tests shall include Plumbing and related equipment.

      1. Hot water system will be tested.
      2. Heat Exchangers will be tested under relevant operating conditions.
      3. DDC control systems will be tested as necessary.

   d. Deferred Testing

      1. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
      2. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

   e. Rescheduled Functional Performance Test

      1. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, contractor shall reimburse the owner for all additional cost the owner incurs as a result of the contractor's failure to be complete and/or to provide operating compliant systems for commissioning. Additional costs include but are not limited to additional

fees charged by the architect, engineer, construction manager and commissioning agent.

2. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed for the commissioning personnel's return trip.

8. Building Turn-Over / Owner Orientation / User Training
    a. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
    b. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
    c. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going Plumbing related problems are being addressed and corrected in a timely and efficient manner.
    d. The CA will assist the owner/user with warranty issues.
    e. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

D. RESPONSIBILITIES OF TEAM MEMBERS

1. Construction Manager (CM)

    A. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
    B. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
    C. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
    D. Coordinate inclusion of commissioning activities in the construction schedule.
    E. Facilitate resolution of deficiencies identified by observation or performance testing.

F. Assist the CA in monitoring the duct leakage testing.

2. Plumbing Contractor (PC)

A. Include cost for commissioning requirements in the contract price.
B. Attend commissioning meetings scheduled by the CA.
C. Verify proper installation and performance of all plumbing services provided.
D. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of equipment.
E. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
F. Provide an electrical system technician to assist during verification and performance testing.
G. Participate in the Functional Performance Tests as required to achieve design intent.
H. Participate in the off-season mode testing as required to achieve design intent.
I. Participate in O&M Training as required by project specifications.

END OF SECTION

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

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

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

C. Copper Unions:
   1. MSS SP-123.
   2. Cast-copper-alloy, hexagonal-stock body.
   3. Ball-and-socket, metal-to-metal seating surfaces.
   4. Solder-joint or threaded ends.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

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

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

B. Solder Filler Metals: ASTM B 32, lead-free alloys.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Meters and Gages for Plumbing Piping and with requirements for drain valves and strainers in Domestic Water Piping Specialties.

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

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Domestic Water Piping Specialties.

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

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

H. 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.

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

J. Install piping to permit valve servicing.

K. 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.

L. Install piping free of sags and bends.

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

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

O. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Meters and Gages for Plumbing Piping.

P. Install thermostats in hot-water circulation piping.

Q. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Meters and Gages for Plumbing Piping.

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

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

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

3.2 JOINT CONSTRUCTION

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

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

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

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

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

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

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

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

3.4 DIELECTRIC FITTING INSTALLATION

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

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in other sections.

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

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

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

3.6 CONNECTIONS

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

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

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

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

3.7 IDENTIFICATION

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

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

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

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

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibs.
2. Open shutoff valves to fully open position.
3. 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.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

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

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

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

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

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

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

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; wrought-copper, solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
3. Drain Duty: Hose-end drain valves.

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

END OF SECTION

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Drain valves.
11. Water-hammer arresters.
12. Air vents.
13. Trap-seal primer valves.
14. Trap-seal primer systems.
15. Specialty valves.
16. Flexible connectors.

1.3 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.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

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

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Arrowhead Brass Products.
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

B. Pressure Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: 3/4".
   a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.

B. Double-Check, Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.

C. Dual-Check-Valve Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.

c. FEBCO; a division of Watts Water Technologies, Inc.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Cash Acme; a division of Reliance Worldwide Corporation.
b. Conbraco Industries, Inc.
c. Honeywell International Inc.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: 3”.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Apollo Valves
b. NIBCO
2. Type: Ball valve with two readout ports and memory-setting indicator.
3. Body: Brass.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Armstrong International, Inc.
b. Cash Acme; a division of Reliance Worldwide Corporation.
c. Conbraco Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 105 deg F.
9. Retain "Tempered-Water Design Flow Rate" Subparagraph below only if flow rate is not indicated on Drawings.
10. Tempered-Water Design Flow Rate: 0.5 gpm.
11. Valve Finish: Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Armstrong International, Inc.
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve 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 union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 105 deg F.

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 that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.
6. Drain: Pipe plug.

2.9 OUTLET BOXES

A. Clothes Washer Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Acorn Engineering Company.
   b. Guy Gray Manufacturing Co., Inc.
   c. Oatey.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

2.10 HOSE BIBBS

A. Hose Bibbs:
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.

3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.11 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Prier Products, Inc.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

2.12 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.

2.13 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
   2. Standard: ASSE 1010 or PDI-WH 201.
   3. Type: Metal bellows.
   4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
   1. Body: Bronze.
   2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 1/2 minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

2.15 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. MIFAB, Inc.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Company, Inc.
   2. Standard: ASSE 1018.
   3. Pressure Rating: 125 psig minimum.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
   6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
   7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.16 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. MIFAB, Inc.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Company, Inc.
   2. Standard: ASSE 1044.
   3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
   4. Cabinet: Surface-mounted steel box with stainless-steel cover.
   5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

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.

6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Four.
8. Size Outlets: NPS 1/2.

2.17 SPECIALTY VALVES

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

2.18 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Flex Pression, Ltd.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 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 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.

G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 06 10 00 "Rough Carpentry."

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

I. Install air vents at high points of water piping.

J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

K. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

L. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

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

C. Prepare test and inspection reports.

3.4 ADJUSTING

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

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

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

END OF SECTION

SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Vertically mounted, in-line, close-coupled centrifugal pumps.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, without amendments, Section 7 - "Service Water Heating."

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alyan Pump Co.
   2. Armstrong Pumps Inc.
   3. Bell & Gossett Domestic Pump; ITT Corporation.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections. Include pump manufacturer's base attachment for mounting pump on concrete base.
   2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
   3. Shaft and Shaft Sleeve: Stainless-steel or steel shaft, with copper-alloy shaft sleeve.
   4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
   5. Bearings: Oil-lubricated; bronze-journal or ball type.
   6. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.

D. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.

E. Capacities and Characteristics:
   1. See Drawings for Capacity and Characteristics.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in 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.

2.3 CONTROLS

A. Pressure Switches: Electric, adjustable for control of water-supply pump.
   1. Type: Water-immersion pressure sensor, for installation in piping.
   2. Enclosure: NEMA 250, Type 4X.
   3. Operation of Pump: On or off.
   4. Transformer: Provide if required.
   5. Power Requirement: 120 V, ac.
   6. Settings: Start pump at 70 PSF and stop pump at 85 PSF.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.

C. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using elastomeric pads. Comply with requirements for concrete base specified in Cast-in-Place Concrete.
   1. Minimum Deflection: 1/4 inch.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.
1. Comply with requirements for vibration isolation devices specified in Vibration Controls for Plumbing Piping and Equipment. Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Hangers and Supports for Plumbing Piping and Equipment.

E. Install pressure switches in water supply piping.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Domestic Water Piping. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
a. Vertically mounted, in-line, close-coupled centrifugal pumps.
b. Comply with requirements for flexible connectors specified in Domestic Water Piping.
2. 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. Comply with requirements for valves specified in General-Duty Valves for Plumbing Piping and comply with requirements for strainers specified in Domestic Water Piping Specialties.
3. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Meters and Gages for Plumbing Piping.

D. Connect pressure switches, to pumps that they control.

E. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Identification for Plumbing Piping and Equipment for identification of pumps.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set pressure switches, for automatic starting and stopping operation of pumps.
5. 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 the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 ADJUSTING

A. Adjust 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

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Waste, Force-Main Piping: 100 psig.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products 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. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ANACO-Husky.
   b. Dallas Specialty & Mfg. Co.
   c. Fernco Inc.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:
1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Grooved-Joint Piping:
1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron-Pipe Appurtenances:
   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) Anvil International.
      2) Shurjoint Piping Products.
      3) Star Pipe Products.
      4) Victaulic Company.
   b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
   c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed 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 B 32, lead free with ASTM B 813, water-flushable flux.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. 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) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.
         3) Mission Rubber Company; a division of MCP Industries, Inc.
         4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
      b. Standard: ASTM C 1173.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:
1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:
a. 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) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company; a division of MCP Industries, Inc.
b. Standard: ASTM C 1460.
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.

5. Pressure Transition Couplings:
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) Cascade Waterworks Mfg. Co.
2) Dresser, Inc.
3) EBAA Iron, Inc.
b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
a. 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) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
b. Description:
1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
a. 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) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca, Inc.

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

4. Dielectric-Flange Insulating Kits:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
b. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:
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) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.
4) Precision Plumbing Products, Inc.
5) Victaulic Company.
b. Description:
1) Standard: IAPMO PS 66
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Earth Moving.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction

loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Vibration and Seismic Controls for Plumbing Piping and Equipment.

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

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

R. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

T. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

U. Install force mains at elevations indicated.

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

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

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

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

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

3.3 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

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

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

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

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.

2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:
    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

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

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in General-Duty Valves for Plumbing Piping.

B. Shutoff Valves:
1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Sanitary Waste Piping Specialties.

3.6 HANGER AND SUPPORT INSTALLATION

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

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

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

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

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

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

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

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.

K. Install supports for vertical copper tubing every 10 feet.

L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

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

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. 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 Sanitary Waste Piping Specialties.
7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

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

F. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in 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 drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping

system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

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

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

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

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

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

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 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 shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and sovent stack fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.
4.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and sovent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.

a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; coupled joints.
3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

G. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

H. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

I. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

J. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:
1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Trench drains.
5. Air-admittance valves.
6. Through-penetration firestop assemblies.
7. Miscellaneous sanitary drainage piping specialties.
8. Flashing materials.
9. Grease interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
1. FOG disposal systems.
2. Grease interceptors.
3. Grease removal devices.
4. Oil interceptors.

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

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

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

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Cast-in-Place Concrete.

B. Coordinate size and location of roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
   2. Standard: ASME A112.14.1.
   3. Size: Same as connected piping.
   4. Body: Cast iron.
   5. Cover: Cast iron with bolted or threaded access check valve.
   6. End Connections: Hubless.
   7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
   8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
      c. Watts Drainage Products Inc.
   2. Size: Same as floor drain outlet.
   3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
   4. Check Valve: Removable ball float.
   5. Inlet: Threaded.
   6. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Canplas LLC.
      b. IPS Corporation.
      c. NDS Inc.

2. Size: Same as connected piping.
3. Body: PVC.
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company; Josam Div.
b. Oatey.
c. Sioux Chief Manufacturing Company, Inc.
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 A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company; Josam Div.

b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; d of Smith Industries, Inc.
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: Countersunk, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
8. Wall Access: Round wall-installation frame and cover.

D. Plastic Floor Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Canplas LLC.
b. IPS Corporation.
c. NDS Inc.
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Commercial Enameling Co.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Not required.
6. Anchor Flange: Not required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Top or Strainer Material: Nickel bronze.
10. Top of Body and Strainer Finish: Nickel bronze.
11. Top Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Trap Material: Cast iron.
14. Trap Pattern: Standard P-trap.

2.4 TRENCH DRAINS

A. Trench Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASME A112.6.3 for trench drains.

3. Material: Ductile or gray iron.
4. Flange: Anchor.
5. Outlet: Bottom.
6. Grate Material: Ductile iron.
7. Grate Finish: Not required.
8. Top Loading Classification: Extra Heavy-Duty.

2.5 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Durgo, Inc.
b. Oatey.
c. ProSet Systems Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

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

B. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. 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.

D. 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.

E. Stack Flashing Fittings:
1. Description: Counter flashing-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.

F. 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.

G. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing.

H. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 GREASE INTERCEPTORS

A. Grease Interceptors
1. Cast-Iron or Steel Grease Interceptors:
2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation wastewater.
3. Plumbing and Drainage Institute Seal: Required.
4. Body Material: Cast iron or steel
5. Interior Lining: Corrosion-resistant enamel
6. Exterior Coating: Corrosion-resistant enamel Body Dimensions: As mentioned in construction documents**.**
7. Flow Rate: As mentioned in construction documents Grease Retention Capacity: As mentioned in construction documents
8. Inlet and Outlet Size: As mentioned in construction documents
9. End Connections: Flanged or Hub
10. Cleanout: Integral
11. Mounting: As mentioned in construction documents Flow-Control Fitting: Required.
12. Operation: Automatic recovery or Manual cleaning

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. 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. 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. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

H. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

I. Install fixture air-admittance valves on fixture drain piping.

J. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

K. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

L. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

M. Assemble open drain fittings and install with top of hub 1 inch above floor.

N. 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.

O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

P. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

Q. Install vent caps on each vent pipe passing through roof.

R. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

T. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.2 CONNECTIONS

A. Comply with requirements in 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.

C. Ground equipment according to Grounding and Bonding for Electrical Systems.

D. Connect wiring according to Low-Voltage Electrical Power Conductors and Cables.

3.3 FLASHING INSTALLATION

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

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Sheet Metal Flashing and Trim.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

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

3.5 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

SECTION 22 13 29 - SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Submersible effluent pumps.
   2. Submersible sewage pumps.
   3. Sewage-pump basins and basin covers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 SUBMERSIBLE EFFLUENT PUMPS

A. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Weil Inc.
      b. Tsurumi Inc.
      c. Federal Pump Corp.
   2. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
   3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, closed or semi-open design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. 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.
10. Controls:
    a. Enclosure: NEMA 250, Type 4X.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    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:
    a. Enclosure: NEMA 250, Type 4X; wall-mounted.
    b. Switch Type: Mercury-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 mercury-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
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.
13. Guide-Rail Supports:
    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

B. Capacities and Characteristics:

1. See Drawings for Capacities and Characteristics.

2.2 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Weil Inc.
      b. Tsurumi Inc.
      c. Bell & Gossett Domestic Pump; ITT Corporation.
   2. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
   3. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
   5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, non-clog, open, or semi-open design for solids handling, and keyed and secured to shaft.
   6. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
   7. Seals: Mechanical.
   8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
   9. 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.
   10. Controls:
      a. Enclosure: NEMA 250, Type 4X.
      b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
      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:
      a. Enclosure: NEMA 250, Type 4X; wall-mounted.
      b. Switch Type: Mercury-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 mercury-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   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.
   13. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

B. Submersible, Quick-Disconnect, Grinder Sewage Pumps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Weil INC.
b. Tsurumi Inc.
c. Barnes; Crane Pumps & Systems.
2. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
5. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; 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. Controls:
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.
10. Controls:
a. Enclosure: NEMA 250, Type 1 wall-mounted.
b. Switch Type: Mercury-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 mercury-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. 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.
12. Guide-Rail Supports:
    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

2.3 SEWAGE-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
    1. Material: Fiberglass.
    2. Reinforcement: Mounting plates for pumps, fittings**,** guide-rail supports if used, and accessories.
    3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
    1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:
    1. See Drawings for Capacities and Characteristics.
    2. Cover Material: Cast iron or steel with bituminous coating.
    3. Cover Diameter: not less than outside diameter of basin top flange.
    4. Manhole Required in Cover: Yes.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Common Motor Requirements for Plumbing Equipment.
    1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Earth Moving.

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:
   1. Comply with HI 1.4 for installation of centrifugal pumps.
   2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting: Install progressing-cavity sewage pumps on concrete base using elastomeric pads. Comply with requirements for concrete base specified in Cast-in-Place Concrete.
   1. Minimum Deflection: 1/4 inch.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Equipment Mounting: Install progressing-cavity sewage pumps using elastomeric pads. Comply with requirements for vibration isolation devices specified in Vibration and Seismic Controls for Plumbing Piping and Equipment.
   1. Minimum Deflection: 1/4 inch.

D. Equipment Mounting: Install progressing-cavity sewage pumps on vibration isolation equipment base. Comply with requirements specified in Vibration and Seismic Controls for Plumbing Piping and Equipment.

E. Wiring Method: Comply with requirements in Low-Voltage Electrical Power Conductors and Cables.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Sanitary Waste and Vent Piping. Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

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

END OF SECTION

SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.
   2. Storm Drainage, Force-Main Piping: 100 psig.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products 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. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, and details.

1.5 INFORMATIONAL SUBMITTALS

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

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ANACO-Husky.
      b. Dallas Specialty & Mfg. Co.
      c. Fernco Inc.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. MG Piping Products Company.
   2. Standard: ASTM C 1277.
   3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
   3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-On-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
   3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
   2. Ductile-Iron-Pipe Appurtenances:
      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) Anvil International.
         2) Shurjoint Piping Products.

3) Star Pipe Products.
4) Victaulic Company.

b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.

c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:
1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings 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 B 32, lead free with ASTM B 813, water-flushable flux.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Non-pressure Transition Couplings:
   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) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.
      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:
      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Non-pressure Transition Couplings:
   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) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company; a division of MCP Industries, Inc.
   b. Standard: ASTM C 1460.
   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.
5. Pressure Transition Couplings:
   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) Cascade Waterworks Mfg. Co.
      2) Dresser, Inc.
      3) EBAA Iron, Inc.
      4) Ford Meter Box Company, Inc. (The)
      5) JCM Industries, Inc.
      6) Romac Industries, Inc.
      7) Smith-Blair, Inc.; a Sensus company.
      8) Viking Johnson; c/o Mueller Co.
   b. Standard: AWWA C219.
   c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
   d. Center-Sleeve Material: Manufacturer's standard.
   e. Gasket Material: Natural or synthetic rubber.
   f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
   1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   2. Dielectric Unions:
      a. 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) Capitol Manufacturing Company.
         2) Central Plastics Company.
         3) Hart Industries International, Inc.
         4) Jomar International Ltd.
         5) Matco-Norca, Inc.
         6) McDonald, A. Y. Mfg. Co.
         7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
         8) Wilkins; a Zurn company.
      b. Description:
         1) Standard: ASSE 1079.
         2) Pressure Rating: 150 psig at 180 deg F .
         3) End Connections: Solder-joint copper alloy and threaded ferrous.
   3. Dielectric Flanges:
      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) Capitol Manufacturing Company.
         2) Central Plastics Company.
         3) Matco-Norca, Inc.
         4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
         5) Wilkins; a Zurn company.
      b. Description:
         1) Standard: ASSE 1079.
         2) Factory-fabricated, bolted, companion-flange assembly.
         3) Pressure Rating: 150 psig.
         4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
   4. Dielectric-Flange Insulating Kits:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         1) Advance Products & Systems, Inc.
         2) Calpico, Inc.
         3) Central Plastics Company.
         4) Pipeline Seal and Insulator, Inc.
      b. Description:
         1) Non-conducting materials for field assembly of companion flanges.
         2) Pressure Rating: 150 psig.
         3) Gasket: Neoprene or phenolic.
         4) Bolt Sleeves: Phenolic or polyethylene.
         5) Washers: Phenolic with steel-backing washers.
   5. Dielectric Nipples:

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) Elster Perfection.
   2) Grinnell Mechanical Products.
   3) Matco-Norca, Inc.
   4) Precision Plumbing Products, Inc.
   5) Victaulic Company.

b. Description:
   1) Electroplated steel nipple complying with ASTM F 1545.
   2) Pressure Rating: 300 psig at 225 deg F.
   3) End Connections: Male threaded or grooved.
   4) Lining: Inert and noncorrosive, propylene.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: High-density, cross-laminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Earth Moving.

3.2 PIPING INSTALLATION

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

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Vibration and Seismic Controls for Plumbing Piping and Equipment.

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of

standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
   1. Building and Horizontal 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.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

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

R. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

S. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

T. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

U. Install force mains at elevations indicated.

V. Plumbing Specialties:
   1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Storm Drainage Piping Specialties.
   2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Storm Drainage Piping Specialties.
   3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Storm Drainage Piping Specialties.

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

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

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

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

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

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. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

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

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

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

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Unshielded, non-pressure transition couplings.
   3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
   4. In Underground Force-Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.

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

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in General-Duty Valves for Plumbing Piping.

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.

2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Storm Drainage Piping Specialties.

3.6 HANGER AND SUPPORT INSTALLATION

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

B. Comply with requirements for pipe hanger and support devices and installation specified in Hangers and Supports for Plumbing Piping and Equipment.
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

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

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

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

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

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

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.

K. Install supports for vertical copper tubing every 10 feet.

L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

B. Connect 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 with cleanout cover flush with floor or in pit with pit cover flush with floor.
   3. Comply with requirements for backwater valves cleanouts and drains specified in Storm Drainage Piping Specialties.

D. Connect force-main piping to the following:
   1. Storm Sewer: To exterior force main.
   2. Sump Pumps: To sump pump discharge.

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

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in 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.
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 re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING

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

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

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

3.11 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 any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.

5. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

C. Aboveground, storm drainage piping shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; 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, non-pressure transition couplings.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Hard copper tube, copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

H. Underground storm drainage force mains NPS 4 and smaller shall be any of the following:
1. Soft copper tube; wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Through-penetration firestop assemblies.
7. Flashing materials.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company.
b. Marathon Roofing Products.
c. MIFAB, Inc.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body:
5. Adjustable Housing Material: Cast iron with threads.
6. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
7. Frame and Cover Shape: Round.
8. Top-Loading Classification: Heavy Duty.
9. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees :
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk or raised head.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts :
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
8. Wall Access: Round wall-installation frame and cover.

2.2 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves :
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hubless.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves :
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Size: Same as floor drain outlet.
3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.

4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

C. Plastic, Horizontal Backwater Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Canplas LLC.
b. IPS Corporation.
c. Zurn Plumbing Products Group; Light Commercial Products Operation.
2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: PVC.
5. Cover: Same material as body with threaded access to check valve.
6. Check Valve: Removable swing check.
7. End Connections: Socket type.

2.3 TRENCH DRAINS

A. Trench Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Josam Company.
b. Smith, Jay R. Mfg. Co.
c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3, for trench drains.
3. Body Material: Cast iron.
4. Flange: Anchor.
5. Outlet: Bottom.
6. Grate Material: Ductile iron.
7. Top-Loading Classification: Extra-Heavy Duty.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ProSet Systems Inc.
2. Standard: ASTM E 814, for through-penetration firestop assemblies.
3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.5 FLASHING MATERIALS

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

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

D. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.

E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

G. Install horizontal backwater valves in floor with cover flush with floor.

H. Install drain-outlet backwater valves in outlet of drains.

I. Install test tees in vertical conductors and near floor.

J. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

K. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

L. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

M. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

N. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

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

3.3 FLASHING INSTALLATION

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

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

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

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 32 00 - DOMESTIC WATER FILTRATION 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. Freestanding cartridge filters.
   2. Off-floor cartridge filters.
   3. Carbon filters.

B. Related Sections:
   1. Section 221119 “Domestic Water Piping Specialties” for plumbing piping strainers.

1.3 ACTION SUBMITTALS

A. Product Data: Stainless steel housing, lead free drinking water, 5 micron spun poly pre-filter element, 0.5 micron carbon block element, dual seal element design.

B. Shop Drawings: For water filtration equipment. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicated dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For water filtration equipment to include in maintenance manuals.

1.5 MATERIALS MAINTENANCE 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. Cartridge-Filter Elements: Elements for cartridge filters equal to 300 percent of amount installed for each size and media indicated.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of water filtration equipment through one source from a single manufacturer.

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

C. Comply with NFS 61, “Drinking Water System Components – Health Effects,” for all components that will be in contact with potable water.

1.7 PROJECT CONDITIONS

A. Usage Summary:
   1. Flow rate should not exceed 90 gpm during peak demand.

B. Feedwater Properties:
   1. Inlet Water Pressure: <100 psi
   2. Water Temperature: <125 F

1.8 COORDINATION

A. Coordinate size and location of concrete bases and/or wall support with actual equipment provided.

PART 2 - PRODUCTS

2.1 CARTRIDGE FILTERS

A. Free-standing Cartridge Filters:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Filtrine IL-90-PFTM-0.5L or comparable product by one of the following, submitted ten days prior to bid:
      a. Filtrine Manufacturing Company – Drinking Water Division
      b. Larco Inc.
      c. Indestruct Coolers
   3. Standard: Comply with NSF 61.
   4. Country of Origin: Made in U.S.A., with no less than 75% US parts/components.
   5. Description: Simplex, free-standing housing with replaceable element(s) for removing suspended particles from water.
      a. Housing: Corrosion resistant: designed to separate feedwater from filtrate and to direct feedwater through water filter element(s); with standpipe and dual-seal element(s).
         1) Pipe Connections NPS 3 and Smaller: Threaded according to ASME B1.20.1.
         2) Manifold: lead-free copper/brass waterways with shutoff valves.
      b. Element(s): Replaceable; with dual-seal caps and o-rings.
   6. Support: Factory supplied mounting tray, with 1/8 inch painted steel 2 inch x 4 inch channel skids for attaching to floor.
   7. Capacity and Characteristics:
      a. Filter Design:
         1) Continuous Flow: 90 gpm
         2) Micron Efficiency: retention of suspended particles 0.5 micrometers and larger of feedwater.
         3) Absorption Efficiency: retention of chlorine taste/odor and lead.
         4) Pressure Drop: Not to exceed 10 psig when clean.
      b. Filter Housing(s):
         1) Quantity: 1
         2) Material: Stainless steel.
         3) Pressure Rating: 125 psig
         4) Seals: EPDM.
         5) Diameter: 13-1/4 inches
         6) Height: 59 inches
         7) Inlet and Outlet Size: NPS 3
      c. Particulate Filter Elements:
         1) Number Required: 7
         2) Nominal Diameter: 2-1/2 inches
         3) Length: 35 inches
         4) Media: Spun polypropylene.
      d. Purifier Housing(s):
         1) Quantity: 4
         2) Material: Stainless steel.

3) Pressure Rating: 125 psig
4) Seals: EPDM.
5) Diameter: 13-1/4 inches
6) Height: 59 inches
7) Inlet and Outlet Size: NPS 3

e. Purifier Elements:
1) Number Required: 28
2) Nominal Diameter: 2-1/2 inches
3) Length: 17-1/2 inches
4) Media: Activated carbon block.

8. Required Factory Installed Options:
a. “Filter Change” alarm light and differential pressure switch
b. Input for BMS connection

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of filters and purifiers.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Install cartridge filters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Equipment Mounting: Install freestanding cartridge filters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete and Section 033053 "Miscellaneous Cast-in-Place Concrete.".
1. Exception: Omit concrete bases if installation directly on floor is indicated.

C. Install filter elements and/or purifier cartridges.

3.3 CONNECTIONS

Coordinate piping installations and specialty arrangements with Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

A. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

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

C. Make piping connections between water filtration equipment and dissimilar-metal water piping with dielectric fittings. Comply with requirements for dielectric fittings specified in section 221116 “Domestic Water Piping”.

D. Install ball or gate shutoff valve on feed-water inlet filtrate-outlet piping. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
1. Exception: Water filtration equipment with factory-installed shutoff valves at locations indicated.

E. Install pressure gauges on feedwater-inlet and filtrate-outlet piping. Comply with requirements for pressure gauges specified in Section 220519 "Meters and Gauges for Plumbing Piping".
   1. Exception: Water filtration equipment with factory-installed gauges at locations indicated.

F. Install valved bypass water piping around water filtration equipment.
   1. Comply with requirements for metal general-duty valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

3.4 IDENTIFICATION

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

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

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and check 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.

C. Domestic water filtration equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. LEED Submittals:
   1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

C. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

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

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Bradford White Corporation.
      b. Lochinvar Corporation.
      c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   2. Standard: ANSI Z21.10.3/CSA 4.3.
   3. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
   4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
      a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
         1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
         2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
      b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Lining: Cement complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   e. Jacket: Steel with enameled finish.
   f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
   g. Temperature Control: Adjustable thermostat.
   h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
   i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
6. Draft Hood: Draft diverter, complying with ANSI Z21.12.

B. Capacity and Characteristics: As per construction drawings

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AMTROL Inc.
   b. Flexcon Industries.
   c. Honeywell International Inc.
   d. Pentair Pump Group (The); Myers.
   e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   f. State Industries.
   g. Taco, Inc.
2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.
4. Capacity and Characteristics:
   a. Working-Pressure Rating: 100 psig.
   b. Capacity Acceptable: 2 gal. minimum.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and balancing valves to provide balanced flow through each domestic-water heater.
   1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in General-Duty Valves for Plumbing Piping.
   2. Comply with requirements for balancing valves specified in Domestic Water Piping Specialties.

F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.

H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
   2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Quality Requirements for retesting and reinspecting requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Cast-in-Place Concrete.

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 48 inches above floor on wall bracket.
1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in General-Duty Valves for Plumbing Piping.

D. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Facility Natural-Gas Piping.

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Domestic Water Piping Specialties.

H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Meters and Gages for Plumbing Piping.

I. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in General-Duty Valves for Plumbing Piping, and comply with requirements for thermometers specified in Meters and Gages for Plumbing Piping.

J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

K. Fill domestic-water heaters with water.

L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Domestic Water Piping.

B. Comply with requirements for fuel-oil piping specified in Facility Fuel-Oil Piping.

C. Comply with requirements for gas piping specified in Facility Natural-Gas Piping.

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

E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

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

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Quality Requirements for retesting and reinspecting requirements and Execution for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Water closets.
2. Flushometer valves.
3. Toilet seats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
1. Product Data for Prerequisite WE 1 and Credit WE 3 , Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets: Floor mounted, bottom outlet, top spud.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. American Standard America.
b. Briggs Plumbing Products, Inc.
c. Capizzi.
d. Crane Plumbing, L.L.C.
e. Ferguson Enterprises, Inc.; ProFlo Brand.
f. Gerber Plumbing Fixtures LLC.
g. Kohler Co.
h. Mansfield Plumbing Products LLC.
i. Peerless Pottery Sales, Inc.
j. TOTO USA, INC.
k. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Bowl:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Siphon jet.
d. Style: Flushometer valve.
e. Height: As specified in construction drawings.
f. Rim Contour: Elongated.
g. Water Consumption: 1.28 gal. per flush.
h. Spud Size and Location: NPS 1-1/2; top.

i. Color: White.
3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
4. Flushometer Valve: Battery operated sensor.

B. Toilet Seat: Open front, elongated.Water Closets: Floor mounted, bottom outlet, child's.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. American Standard America.
b. Briggs Plumbing Products, Inc.
c. Capizzi.
d. Crane Plumbing, L.L.C.
e. Ferguson Enterprises, Inc.; ProFlo Brand.
f. Gerber Plumbing Fixtures LLC.
g. Kohler Co.
h. Mansfield Plumbing Products LLC.
i. Peerless Pottery Sales, Inc.
j. TOTO USA, INC.
k. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Bowl:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Siphon jet or reverse trap.
d. Style: Flushometer valve.
e. Height: Child/as specified in the construction drawings.
f. Rim Contour: Modified elongated or regular.
g. Water Consumption: 1.28 gal. per flush.
h. Spud Size and Location: NPS 1-1/2; back.
i. Color: White.
3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
4. Flushometer Valve: Battery operated sensor.
5. Toilet Seat: IAPMO/ANSI Z124.5, Type A (residential), Shape 3 (elongated rim), open front, without cover, and shaped to match bowl.

2.2 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Coyne & Delany Co.
b. Gerber Plumbing Fixtures LLC.
c. Sloan Valve Company.
d. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
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. Battery operated sensor type.
9. Style: Exposed.
10. Consumption: 1.28 gal. per flush.
11. Minimum Inlet: NPS 1.

12. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. American Standard America.
b. Bemis Manufacturing Company.
c. Centoco Manufacturing Corporation.
d. Church Seats.
e. Jones Stephens Corp.; Comfort Seat Brand.
f. Kohler Co.
g. Olsonite Seat Co.
h. Sanderson Plumbing Products, Inc.
i. Sperzel of Lexington.
j. TOTO USA, INC.
k. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Non-corroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Water-Closet Installation:
1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

B. 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 that are easy for people with disabilities to reach.

C. Install toilet seats on water closets.

D. 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 Escutcheons for Plumbing Piping.

E. 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 Joint Sealants.

3.2 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 Domestic Water Piping.

C. Comply with soil and waste piping requirements specified in Sanitary Waste and Vent Piping.

3.3 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.

3.4 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

SECTION 22 42 13.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Urinals.
2. Flushometer valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
1. Product Data for Prerequisite WE 1 and Credit WE 3: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals: Wall hung, back outlet, siphon jet, accessible.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. American Standard America.
b. Briggs Plumbing Products, Inc.
c. Ferguson Enterprises, Inc.; ProFlo Brand.
d. Gerber Plumbing Fixtures LLC.
e. Kohler Co.
f. Mansfield Plumbing Products LLC.
g. Peerless Pottery Sales, Inc.
2. Fixture:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Siphon jet with extended shields.
d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
e. Water Consumption: Low.
f. Spud Size and Location: NPS 3/4; top.
g. Outlet Size and Location: NPS 2; back.
h. Color: White.
3. Flushometer Valve: Battery operated sensor type.
4. Waste Fitting:
a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.
5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.2 URINAL FLUSHOMETER VALVES

A. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Coyne & Delany Co.
b. Gerber Plumbing Fixtures LLC.
c. Hydrotek International, Inc.
d. Kohler Co.
e. Moen Incorporated.
f. Sloan Valve Company.
g. TOTO USA, INC.
h. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
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. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Consumption: 0.125 gal. per flush.
11. Minimum Inlet: NPS 3/4.
12. Minimum Outlet: NPS 3/4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

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

3.2 INSTALLATION

A. Urinal Installation:
1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:
1. Install supports, affixed to building substrate, for wall-hung urinals.
2. 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 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 Joint Sealants.

3.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with water piping requirements specified in Domestic Water Piping.

C. Comply with soil and waste piping requirements specified in Sanitary Waste and Vent Piping.

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

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

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

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Lavatories.
2. Faucets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1 and Credit WE 3: Documentation indicating flow and water consumption requirements.

C. 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: For lavatories and faucets to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory: Vitreous china, wall mounted, with back.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. American Standard America.
b. Briggs Plumbing Products, Inc.
c. Capizzi.
d. Crane Plumbing, L.L.C.
e. Ferguson Enterprises, Inc.; ProFlo Brand.
f. Gerber Plumbing Fixtures LLC.
g. Kohler Co.
h. Mansfield Plumbing Products LLC.
i. Peerless Pottery Sales, Inc.
j. TOTO USA, INC.
k. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Fixture:
a. Standard: ASME A112.19.2/CSA B45.1.
b. Type: For wall hanging.
c. Nominal Size: Oval, 19 by 16 inches.
d. Faucet-Hole Punching: One hole.
e. Faucet-Hole Location: Top.
f. Color: White.
g. Mounting Material: Chair carrier.
3. Faucet: Solid-Brass, Automatically Operated Lavatory Faucets.

4. Support: ASME A112.6.1M

B. Lavatory: Ledge back, vitreous china, wall mounted.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard America.
      b. Briggs Plumbing Products, Inc.
      c. Capizzi.
      d. Crane Plumbing, L.L.C.
      e. Ferguson Enterprises, Inc.; ProFlo Brand.
      f. Gerber Plumbing Fixtures LLC.
      g. Kohler Co.
      h. Mansfield Plumbing Products LLC.
      i. Peerless Pottery Sales, Inc.
      j. TOTO USA, INC.
      k. Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Fixture:
      a. Standard: ASME A112.19.2/CSA B45.1.
      b. Type: For wall hanging.
      c. Nominal Size: Oval, 19 by 16 inches.
      d. Faucet-Hole Punching: One hole.
      e. Faucet-Hole Location: Top.
      f. Color: White.
      g. Mounting Material: Chair carrier.
   3. Faucet: Solid-Brass, Automatically Operated Lavatory Faucets.
   4. Support: ASME A112.6.1M

C. Lavatory: Slab type, vitreous china, wall mounted.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Standard America.
      b. Briggs Plumbing Products, Inc.
      c. Capizzi.
      d. Crane Plumbing, L.L.C.
      e. Ferguson Enterprises, Inc.; ProFlo Brand.
      f. Gerber Plumbing Fixtures LLC.
      g. Kohler Co.
      h. Mansfield Plumbing Products LLC.
      i. Peerless Pottery Sales, Inc.
      j. TOTO USA, INC.
      k. Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Fixture:
      a. Standard: ASME A112.19.2/CSA B45.1.
      b. Type: For wall hanging.
      c. Nominal Size: Oval, 19 by 16 inches.
      d. Faucet-Hole Punching: One hole.
      e. Faucet-Hole Location: Top.
      f. Color: White.
      g. Mounting Material: Chair carrier.
   3. Faucet: Solid-Brass, Automatically Operated Lavatory Faucets.
   4. Support: ASME A112.6.1M

D. Lavatory : Wheelchair, vitreous china, wall mounted.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. American Standard America.
   b. Briggs Plumbing Products, Inc.
   c. Capizzi.
   d. Crane Plumbing, L.L.C.
   e. Ferguson Enterprises, Inc.; ProFlo Brand.
   f. Gerber Plumbing Fixtures LLC.
   g. Kohler Co.
   h. Mansfield Plumbing Products LLC.
   i. Peerless Pottery Sales, Inc.
   j. TOTO USA, INC.
   k. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Fixture:
   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: Slab or wheelchair.
   c. Nominal Size: Rectangular, 27 by 20 inches.
   d. Faucet-Hole Punching: Three holes.
   e. Faucet-Hole Location: Top.
   f. Color: White.
   g. Mounting: For concealed-arm carrier.
3. Faucet: Solid-Brass, Automatically Operated Lavatory Faucets.
4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.

2.2 SOLID-BRASS, SENSOR OPERATED FAUCETS

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

B. Lavatory Faucets: Sensor Operated-type, commercial, solid-brass valve.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. American Standard America.
   b. Bradley Corporation.
   c. Chicago Faucets.
   d. Delta Faucet Company.
   e. Elkay Manufacturing Co.
   f. Grohe America, Inc.
   g. Just Manufacturing.
   h. Kohler Co.
   i. Moen Incorporated.
   j. Speakman Company.
   k. T & S Brass and Bronze Works, Inc.
   l. Zurn Industries, LLC; Commercial Brass and Fixtures.
   m. Sloan
   n. Zurn
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: Centerset.
5. Body Material: Commercial, solid brass.

6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm.
8. Mounting Type: Deck, exposed.
9. Spout: Rigid type.
10. Spout Outlet: Aerator.
11. Drain: Grid Drain.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," 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 1/2.
2. Chrome-plated, soft-copper flexible tube ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose 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: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. 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 Escutcheons for Plumbing Piping.

D. 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 Joint Sealants.

E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Plumbing Piping Insulation.

3.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Domestic Water Piping.

C. Comply with soil and waste piping requirements specified in Sanitary Waste and Vent Piping.

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh 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

SECTION 22 42 16.16 - COMMERCIAL SINKS

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. Service basins.
2. Handwash sinks.
3. Pantry/Kitchen sinks.
4. Classroom sinks.
5. Sink faucets.
6. Supply fittings.
7. Waste fittings.

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 sinks.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

A. Service Basins: Terrazzo, floor mounted.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Acorn Engineering Company.
b. Crane Plumbing, L.L.C.
c. Florestone Products Co., Inc.
d. Stern-Williams Co., Inc.
2. Fixture:
a. Standard: IAPMO PS 99.
b. Shape: Rectangular.
c. Nominal Size: As indicated.
d. Height: As indicated.
e. Tiling Flange: On one side.
f. Rim Guard: On all exposed top surfaces.
g. Color: Not applicable
h. Drain: Grid with NPS 3 outlet.
3. Mounting: On floor and flush to wall.
4. Faucet: As indicated.

2.2 PANTRY/KITCHEN SINKS

A. Pantry/Kitchen Sinks: Stainless steel, wall mounted.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Tabco.
b. AERO Manufacturing Company.
c. Amtekco Industries, Inc.
d. Eagle Group; Foodservice Equipment Division.
e. Elkay Manufacturing Co.
f. Griffin Products, Inc.
g. Just Manufacturing.

2. Fixture:
a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
b. Type: Basin with radius corners, back for faucet, and support brackets.
c. Nominal Size: As indicated.

3. Faucet: As indicated
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
6. Support: ASME A112.6.1M, Type II, sink carrier.

2.3 CLASSROOM SINKS

A. Stainless steel, wall mounted.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Advance Tabco.
b. AERO Manufacturing Company.
c. Amtekco Industries, Inc.
d. Eagle Group; Foodservice Equipment Division.
e. Elkay Manufacturing Co.
f. Griffin Products, Inc.
g. Just Manufacturing.

2. Fixture:
a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
b. Type: Basin with radius corners, back for faucet, and support brackets.
c. Nominal Size: As indicated.

3. Faucet: As indicated.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
6. Support: ASME A112.6.1M, Type II, sink carrier.

2.4 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 , "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Standard America.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Elkay Manufacturing Co.
f. GROHE America, Inc.
g. Just Manufacturing.

h. Kohler Co.
i. Moen Incorporated.
j. Speakman Company.
k. T & S Brass and Bronze Works, Inc.
l. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 1.5 gpm.
8. Handle(s): Lever.
9. Mounting Type: Deck, exposed Back/wall, exposed.
10. Spout Type: Swivel gooseneck.
11. Vacuum Breaker: Required for hose outlet.
12. Spout Outlet: Aerator.

2.5 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," 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: Wheel handle.

F. Risers:
1. NPS 1/2
2. Chrome-plated, soft-copper flexible tube.

2.6 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: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

2.7 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

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

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in General-Duty Valves for Plumbing Piping.
   2. Install stops in locations where they can be easily reached for operation.

F. 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 Escutcheons for Plumbing Piping.

G. 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 Joint Sealants.

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Plumbing Piping Insulation.

3.3 CONNECTIONS

A. Connect sinks 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 Domestic Water Piping.

C. Comply with soil and waste piping requirements specified in Sanitary Waste and Vent Piping.

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 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

SECTION 22 42 23 - COMMERCIAL SHOWERS, RECEPTORS, AND BASINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Shower faucets.
2. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
3. Product Data for Prerequisite WE 1 and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data.

PART 2 - PRODUCTS

2.1 SHOWER FAUCETS

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

B. Shower Faucets:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. American Standard America.
b. Chicago Faucets.
c. Ferguson Enterprises, Inc.; ProFlo Brand.
d. Kohler Co.
e. Lawler Manufacturing Co., Inc.
f. Leonard Valve Company.
g. Matco-Norca.
h. Moen Incorporated.
i. Powers; a division of Watts Water Technologies, Inc.
j. Speakman Company.
k. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:
a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Maximum Flow Rate: 1.5 gpm unless otherwise indicated.
e. Mounting: Concealed.
f. Operation: Single-handle, push-pull or twist or rotate control.
g. Antiscald Device: Integral with mixing valve.
h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
4. Supply Connections: NPS 1/2.

5. Shower Head:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Type: Ball joint with arm and flange.
   c. Shower Head Material: Metallic with chrome-plated finish, manual proof.
   d. Spray Pattern: Fixed.
   e. Integral Volume Control: Required.
   f. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
   g. Temperature Indicator: Not required.

2.2 GROUT

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

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble shower components according to manufacturers' written instructions.

B. Install water-supply piping with stop on each supply to each shower faucet.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with shower. Comply with valve requirements specified in General-Duty Valves for Plumbing Piping.
   2. Install stops in locations where they can be easily reached for operation.

C. Install shower flow-control fittings with specified maximum flow rates in shower arms.

D. Set shower receptors in leveling bed of cement grout.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Escutcheons for Plumbing Piping.

3.2 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 Domestic Water Piping.

C. Comply with traps and soil and waste piping requirements specified in Sanitary Waste and Vent Piping.

3.3 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.4 CLEANING AND PROTECTION

A. After completing installation of showers, inspect and repair damaged finishes.

B. Clean showers, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 47 13 - DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes drinking fountains and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Drinking Fountains : Stainless steel, wall mounted.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Elkay Manufacturing Co.
      b. Filtrine Manufacturing Company.
      c. Halsey Taylor.
      d. Haws Corporation.
      e. Murdock-Super Secur; a division of Acorn Engineering Company.
      f. Stern-Williams Co., Inc.
      g. Tri Palm International, LLC; Oasis Brand.
      h. Crane Plumbing, L.L.C.
      i. Kohler Co.
   2. Standards:
      a. Comply with ASME A112.19.3/CSA B45.4.
      b. Comply with NSF 61.
   3. Type Receptor: With back.
   4. Receptor Shape: Rectangular Round.
   5. Back Panel: Stainless-steel wall plate behind drinking fountain.
   6. Bubblers: One, with adjustable stream regulator, located on deck.
   7. Control: Push button Push bar.
   8. Drain: Grid type 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 chrome-plated brass P-trap and waste.
   11. Support: ASME A112.6.1M, Type III lavatory carrier.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

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

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. 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, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in General-Duty Valves for Plumbing Piping.

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

E. Install 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 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 Joint Sealants.

3.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Domestic Water Piping.

C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Comply with valve requirements specified in General-Duty Valves for Plumbing Piping.

D. Comply with soil and waste piping requirements specified in Sanitary Waste and Vent Piping.

3.4 ADJUSTING

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

3.5 CLEANING

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

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

C. Provide protective covering for installed fixtures.

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

END OF SECTION

SECTION 23 01 00 - GENERAL PROVISIONS - MECHANICAL

1. GENERAL

A. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical System(s) indicated or specified in the Contract Documents.

B. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

C. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor (or Construction Manager, if applicable), responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect (if applicable), then to the Engineer. Also, this section of the specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

D. It is the intent of this Contract to deliver to the Owners a "new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

E. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

F. Definitions and Abbreviations

(1) Contractor - Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of mechanical work (Controls, Plumbing, HVAC, Sprinkler, Gas Systems, etc.) or, the General Contractor.

(2) Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.

(3) Architect - The Architect of Record for the project.

(4) Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

(5) Provide - Furnish and install complete, tested and ready for operation.

(6) Install - Receive and place in satisfactory operation.

(7) Indicated - Listed in the Specifications, shown on the Drawings or Addenda thereto.

(8) Typical - Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

(9) Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owners, etc.

(10) Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

(11) OSHA - Office of Safety and Health Administration.

(12) IBC – International Building Code

(13) The Project - All of the work required under this Contract.

(14) NEC - National Electrical Code.

(15) NFPA - National Fire Protection Association.

(16) ASME - American Society of Mechanical Engineers.

(17) AGA - American Gas Association.

(18) SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

(19) ANSI - American National Standards Institute.

(20) ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.

(21) NEMA - National Electrical Manufacturers Association.

(22) UL - Underwriters Laboratories.

(23) ADA - Americans with Disabilities Act.

(24) IMC - International Mechanical Code.

(25) IECC - International Energy Conservation Code.

(26) IFGC - International Fuel Gas Code.

2. INTENT

A. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.

B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

3. DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The drawings are not intended to show every item which may be necessary to complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.

C. The drawings and specifications shall be considered to be cooperative and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.

F. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

G. Unless dimensioned, the mechanical drawings only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work.

H. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Landscaping, Structural, Surveys, etc., to ensure that the work he intends to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.

I. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

L. Special Note: Always check ceiling heights indicated on Architectural Drawings and Schedules and ensure that they may be maintained after all mechanical and electrical equipment is installed. Do not install equipment in the affected area until the conflict is resolved.

4. EXAMINATION OF SITE AND CONDITIONS

A. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His proposal shall cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests approval of materials and/or equipment of different physical size, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, electrical services, etc., from that indicated. Any requests for Substitutions shall comply with Division 1 requirements and procedures. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.

B. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the provisions of Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineers.

D. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

6. SUPERVISION OF WORK

A. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent onsite.

7. CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, water and/or sewer system development charge, etc. in connection with his work. He shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. He shall hire an independent Registered Engineer to witness installations and provide necessary certifications where required by utility companies, municipal agencies or others that have review authority. He shall also obtain all required certificates of inspection for his work and deliver same to the Engineers before request for acceptance and final payment for the work. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall also be versed in all Codes, Rules and Regulations pertinent to his part of the work prior to submission of a proposal.

B. The Contractor shall include in his work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

D. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable. Where required by the Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.

E. All plumbing work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such plans are in the hands of the Contractor.

F. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the International Building Code (IBC) and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association. Contractor shall secure a permit from the Division of HVAC. Final inspection certificate shall be provided by Contractor and a copy included in Operation and Maintenance Manuals.

8. EQUIPMENT AND PIPING SUPPORT

A. Each piece of equipment, apparatus, piping, or conduit suspended from the structure or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

9. DUCT AND PIPE MOUNTING HEIGHTS

A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure.

10. CORRECTION PERIOD

A. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of his operator or other employees. Refer to other sections for any special or extra warranty requirements.

B. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.

C. All compressors shall have five year warranty.

11. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

12. CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

13. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. SURVEY, MEASUREMENTS AND GRADE

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the contract documents, he shall promptly notify the Engineer and shall not proceed with this work until he has received instructions from the Engineer on the disposition of the work.

15. TEMPORARY USE OF EQUIPMENT

A. The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Engineers. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.

B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

C. A pre-start-up conference shall be held with the Architect, Owner, General Contractor and the Mechanical Contractor. Equipment shall not be started until after this meeting.

D. During all phases of construction:

(1) Heat Pump Units:

a. At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.

b. On the outside of all return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the "construction" filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.

c. At substantial completion of the project the entire unit shall be cleaned to present a like "new" unit for the Owner and all filters shall be replaced with new.

(2) Outside Air Units:

a. These units shall not be used for temporary heating and cooling by the Contractor. They shall, however, be made operational, tested, etc. as specified during construction by the Contractor. Three complete sets of filters are required for each unit. In each unit, install one set of filters during construction. In each unit, install one set of filters at substantial completion. For each unit, leave third set of filters in boxes in appropriate mechanical room as a spare set for the Owner. Dispose of all construction filters.

b. At substantial completion of the project the entire unit shall be cleaned to present a like "new" unit for the Owner and all filters shall be replaced with new.

16. TEMPORARY SERVICES

A. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

17. RECORD DRAWINGS

A. The Contractor shall ensure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all

exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these marked up plans along with a scanned electronic copy in PDF format.

18. MATERIALS AND WORKMANSHIP

A. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.

B. Materials and equipment, where applicable, shall bear Underwriters' Laboratories label where such a standard has been established.

C. Use extreme care in the selection of equipment and its installation to ensure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.

D. Each length of pipe, fitting, trap, fixture and device used in the hydronic or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.

E. All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a data plate indicating required horsepower, voltage, phase and ampacity.

19. COOPERATION AND COORDINATION WITH OTHER TRADES

A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay. Refer to Division 1 for specific coordination requirements.

B. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

20. QUALIFICATIONS OF WORKMEN

A. All mechanical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workman shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of Architect, Contractor, etc.

B. All sheet metal, insulation and pipe fitting work shall be installed by workmen normally engaged or employed in these respective trades, except where only small amounts of such work are required and are within the competency of workmen directly employed by the Contractor involved.

C. All automatic control systems shall be installed by workmen normally engaged or employed in this type work, except in the case of minor control requirements (residential type furnaces, packaged HVAC equipment with integral controls, etc.) in which case, if a competent workman is the employee of this Contractor, he may be utilized subject to review of his qualifications by the Engineer and after written approval from same.

D. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

21. CONDUCT OF WORKMEN

A. Refer to Division I requirements.

22. PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, etc., shall be properly plugged or capped during construction. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at his own expense.

23. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

24. BROKEN LINES AND PROTECTION AGAINST FREEZING

A. No conduits, piping, troughs, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. If in doubt, contact the Engineer. Do not install piping across or near openings to the outside whether they are carrying static or moving fluids or not. Special Note: Insulation on piping does not necessarily ensure that freezing will not occur.

25. CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish and debris caused by his operations; and at the completion of the work, shall remove all

rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may request cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

26. CONCRETE WORK

A. The Contractor shall be finally responsible for the provisions of all concrete work required for the installation of any of his systems or equipment. He may, at his option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Mechanical work shall be 3000 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be set on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into floors to anchor pads.

B. All mechanical equipment (tanks, heat pumps, pumps, air handling units, etc.) shall be set on a minimum of 4" tall concrete pads. Pads shall be taller where required for condensate traps. All concrete pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with ½" round bars on 6" centers both ways. Bars shall be approximately 3" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all square edges one-half inch.

C. In general, concrete pads for equipment shall extend four (4) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space.

D. Exterior concrete pads shall be four (4) inches minimum above grade and four (4) inches below grade on a tamped four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (1/2) inch chamfer on exposed edges.

E. All exterior below grade concrete structures (utility vaults, grease traps, manholes, etc.) shall be provided with exterior waterproofing. Waterproofing shall be hot-fluid applied rubberized-asphalt waterproofing membrane with elastomeric sheets at edges, corners, and terminations of membrane for continuous watertight construction. Apply in layers and reinforce as required to provide uniform seamless membrane minimum 4mm thickness. Also, seal penetrations into and out of the structure watertight. Provide Link-Seal modular seal or equal.

27. NOISE, VIBRATION OR OSCILLATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means. Unitary equipment, such as small room heating units, small exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineers.

28. ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.

B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, etc.

C. The Contractor shall provide access panels for each concealed valve, control damper or other device requiring service as shown on engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work.

29. MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily.

B. Utilities and lines, where known, are indicated on the drawings. Locations and sizes are approximate. Prior to any excavation being performed, the Contractor shall ascertain that no utilities or lines are endangered by new excavation. Exercise extreme caution in all excavation work.

C. If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation or blasting in the respective area.

D. Cutting into existing utilities and services where required shall be done in coordination with and only at times designated by the Owner of the utility.

E. The Contractor shall repair to the satisfaction of the Engineer, any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted with ten feet of electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only.

G. Protect all new or existing lines from damage by traffic, etc. during construction. Repairs or replacement of such damage shall be at the sole expense of the party responsible. The geothermal lines shall clearly be marked throughout the demolition of the existing facility and protected from heavy traffic and excavation. Any damage to the pipes shall be repaired at no additional cost to the Owner.

30. SMOKE AND FIRE PROOFING

A. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the IBC. Patch all openings around ductwork and piping with appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at fire walls, floors, ceilings, roofs, etc. All fireproofing shall be UL listed for the required rating. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

31. MOTORS

A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with standards of A.S.A. C50, conforming to this and all applicable standards for insulation resistance and dielectric strength.

B. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box, and N.E.C. required disconnecting means as specified or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

C. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 26 of Specifications for further requirements related to installation of motors.

32. CUTTING AND PATCHING

A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Structural Engineer.

C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

33. CURBS, PLATES, ESCUTCHEONS & AIR TIGHT PENETRATIONS

A. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.

B. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

C. Seal all duct, pipe, conduit, etc., penetrations through walls and floors air tight. If wall or floor assembly is rated then use similarly rated sealing method.

34. WEATHERPROOFING

A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

35. OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

A. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list of representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.

B. Refer to Division I for operations and maintenance manual requirements.

C. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.

D. The Contractor shall frame under Lexan in the main mechanical room all temperature control diagrams and all piping diagrams.

36. PAINTING

A. In general, all finish painting shall be accomplished under the Painting Section of the specifications by the Contractor; however, unless otherwise specified under other sections of these specifications, the following items shall be painted:

(1) All exposed piping, valve bodies and fittings (bare and insulated), including hangers, platforms, etc.

(2) All mechanical equipment not factory finished. Aluminum and stainless steel equipment, motors, identification plates, tags, etc. shall not be painted. All rust and foreign matter shall be thoroughly removed from surfaces prior to painting. All baked enamel factory finish of equipment which may have been scratched or chipped shall be touched up with the proper paint as recommended and supplied by the manufacturer.

(3) All ductwork exposed in finished areas (bare and insulated), all grilles, diffusers, etc. not factory finished. Paint the inside surfaces of all interior duct surfaces visible from any register, grille or diffuser opening on all jobs; surfaces shall receive one (1) prime coat of Rustoleum 1225 red "galvinoleum" or other approved equivalent primer and rust inhibitor and one (1) coat of Rustoleum 1579 jet black "Speedy Dry" enamel or approved equivalent applied in accordance with the manufacturer's recommendations.

(4) All insulated piping, ductwork and equipment shall be properly prepared for painting by the Contractor where mechanical items are to be painted. In the case of externally insulated duct and pipe, the Contractor shall provide 6 oz. canvas jacket with fire retardant lagging. The jacket shall be allowed to dry properly before applying paint to avoid shrinking after painting and exposing unpainted surfaces. The Contractor, at his option, may provide double wall ductwork in lieu of externally insulated ductwork with canvas jacket and lagging.

37. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring thru starters, and shall furnish and install all required starters not factory mounted on equipment.

B. The Contractor shall, regardless of voltage, furnish and install all temperature control wiring and all associated interlock wiring, all equipment control wiring and conduit for the equipment that the Contractor furnishes. He may, at his option, employ at his own expense, the Electrical Contractor to accomplish this work.

C. After all circuits are energized and completed, the Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of the Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.

D. The Contractor shall furnish motor starters of the type and size required by the manufacturer for all equipment provided by him, where such starters are necessary. Starters shall have overloads for each phase.

38. FINAL CONNECTIONS TO EQUIPMENT

A. The Contractor shall finally connect to mechanical services, any terminal equipment, appliances, etc., provided under this and other divisions of the work. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer's recommendations. If in doubt, contact the Engineers prior to installation.

39. REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost.

40. INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

41. HAZARDOUS MATERIALS

A. Refer to Division 0 for Hazardous material abatement requirements. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall ensure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees,

agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

42. ABOVE-CEILING AND FINAL PUNCH LISTS

A. Refer to Division I for these requirements.

END OF SECTION

SECTION 23 02 00- SCOPE OF THE MECHANICAL WORK

1. GENERAL

A. The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following:

(1) All mechanical exhaust systems.

(2) All insulation associated with mechanical systems.

(3) Condensate drainage systems.

(4) Complete heating, ventilation and air conditioning systems.

(5) Final connection of all mechanical equipment furnished by others (e.g., kitchen equipment).

(6) Complete balancing of air and water systems.

(7) All applicable services and work specified in Section 230100; General Provisions - Mechanical.

(8) All specified or required control work.

(9) Provide all required motor starters, etc. not provided under the electrical sections.

(10) One year guarantee of all mechanical equipment, materials and workmanship starting at Substantial Completion. Extended warrantees where indicated within individual specification sections.

(11) Thorough instruction of the owner's maintenance personnel in the operation and maintenance of all mechanical equipment.

(12) Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.

(13) Approved supervision of the mechanical work.

(14) Excavation, backfilling, cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.

(15) Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and shall include such requirements in his base bid.

(16) Procurement of all required permits and inspections, including fees for all permits and inspection services and submission of final certificates of inspection to the Engineers (Plumbing, HVAC, etc.).

(17) Factory start-up of all major equipment (including terminal HVAC equipment) and submission of associated factory start-up reports to the Engineer.

END OF SECTION

SECTION 23 03 00 - SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS & TOOLS

1. GENERAL

A. The Contractor's attention is directed also to the General and Special Conditions in Division 01 and Section 230100 - General Provisions - Mechanical as well as to all other Contract Documents as they may apply to his work.

B. The Contractor shall prepare and submit to the Engineer, through the General Contractor and the Architect (where applicable) within thirty (30) days after the date of the Contract, shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter.

C. Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.

D. All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General Contractor and the Architect (if applicable) to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.

E. It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

F. The Engineers review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for: adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project. Any items that differ from the Drawings or Specifications shall be flagged by the Contractor so the Engineer will be sure to see the item. The Contractor is responsible for meeting the Drawings and Specification requirements.

G. Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.

H. If the Contractor fails to indicate in the submittal which options or features the product is provided with, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the drawings; and the Contractor shall be required to furnish all materials in accordance with this list.

I. Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors. Color samples shall be furnished with the shop drawing submission for such equipment.

J. Shop Drawing Submittals

(1) All submittals for HVAC equipment shall include all information specified. This shall include air and water pressure drops, RPM, noise data, face velocities, horsepower, voltage motor type, steel or aluminum construction, and all accessories clearly marked.

(2) All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule.

(3) All items submitted shall be designated with the same identifying tag as specified on each sheet.

(4) Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

2. SHOP DRAWINGS

Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

Duct Insulation (Internal and External)
Pipe Insulation
Hydronic Specialties
(2) Chemical Treatment System
Pumps and Circulators (HVAC)
Heat Pumps
Controls
Dedicated Outside Air Unit
HVAC Equipment
Registers, Grilles, Diffusers
Hydronics
Valves

SPECIAL NOTES:

(1) Refer to Division I requirements for operations and maintenance manuals.

(2) Shop drawings for the Control Systems shall include detailed, scaled plans and schematic diagrams indicating the function and operation of the system.
(3) The Contractor shall submit Material Safety Data sheets for all chemical treatment and anti-freeze solutions.

3. LEED
A. EA prerequisite 3/EA credit 4, Refrigerant Management: Provide manufacturer’s cut sheets for all cooling equipment highlighting the type and quantity of refrigerants used, including ODP & GWP. Provide manufacturer’s cut sheets indicating the absence of halons, CFCs and HCFS in the fire-suppression systems.
B. EA credit 5: Measurement and Verification: Provide cut sheets and manufacturer’s product data for all controls systems, highlighting electrical metering, gas metering, water metering, and any trending capability components.

C. EQ prerequisite 1: Provide manufacturers cut sheet supplying total air flow and total outside airflow of relevant HVAC equipment.

D. EQ credit 1: Outdoor Air Delivery Monitoring: Provide manufacturer's cut sheets highlighting the installed air flow and carbon dioxide monitoring system components and sequence of controls shop drawing documentation, including CO2 differential set-points and alarm capabilities.

4. SPECIAL WRENCHES, TOOLS, ETC.

(1) The Contractor shall furnish, along with equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed under the Contract. Wrenches shall include necessary keys, handles and operators for valves, cocks, hydrants, etc. A reasonable number of each shall be furnished.

5. BALANCE REPORTS

A. Following completion of the testing, provide an electronic copy of the balance report. Upon substantial completion of the project, the Contractor shall submit to the Engineers four (4) bound hard copies of the Certified Air and Hydronic Balance Report.

END OF SECTION

SECTION 23 04 00 - DEMOLITION AND SALVAGE

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

2. DEMOLITION

A. INTENT

It is the intent of this section to completely remove all components of any existing mechanical system no longer in use that will be open to view in, or will interfere with the operations of the completed building, or which will, in any way, interfere with project construction. Components of the existing mechanical systems which do not meet the above criteria, may be abandoned in place in a safe, workmanlike, code approved manner.

B. HVAC

(1) Remove from the project area all piping not to be reused and hangers, specialties, etc. that are accessible or that become accessible during construction and/or interfere in any way with any part of the construction or would be exposed in the completed building.

(2) Remove all temperature controls and related items that are accessible or become accessible during construction.

(3) Remove all existing heating and ventilating equipment where indicated to be demolished from the building.

(4) The Contractor shall be responsible for the removal and/or relocation of any HVAC piping, equipment, fittings, valves, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Structural, Mechanical or Electrical Systems at no increase in the contract price.

(5) Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where HVAC equipment is removed.

(6) Unless otherwise noted, when removing equipment sitting on a concrete pad, also remove the concrete pad and patch and repair floor to match adjacent surfaces.

C. THERMOSTAT, THERMOMETER, AND MERCURY BEARING DEVICE DISPOSAL

(1) The Contractor shall dispose of all mercury bearing materials in accordance with state and federal guidelines. The Contractor shall take all necessary precautions to not accidentally allow mercury to be released from the device during demolition.

3. SALVAGE

A. It is the intent of this section to deliver to the owner all components of any mechanical system which may be economically reused by him. The Contractor shall make every effort to remove reusable components without damage and deliver them to a location designated by the Owner.

B. Components to be delivered to the owner shall be specifically identified by the owner's representative prior to beginning the demolition. The owner will provide the list of items to be delivered to the owners designated site. These items shall include

(1) Two unit ventilators
(2) Two hydronic pumps

C. Other items become the property of the Contractor and are to be removed from the site.

END OF SECTION

SECTION 23 05 00 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

   A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Food Service, and Structural drawings, to the end that complete coordination between trades will be affected. Special attention shall be given to the points where ducts or piping must cross other ducts or piping, where lighting fixtures must be recessed in ceilings, and where ducts, piping and conduit must fur into walls, soffits, columns, etc. It shall be the responsibility of the Contractor to leave the necessary room for other trades. No extra compensation will be allowed to cover the cost of removing piping, conduit, ducts, etc., or equipment found encroaching on space required by others.

   B. The Contractor shall be responsible for coordination with the Electrical trade to insure that he has made provision for connections, operational switches, disconnect switches, fused disconnects, etc. for electrically operated equipment provided under this division of the specifications, or called for on the plans.

   C. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other Contracts, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of piping, ductwork, conduit, and equipment not installed in accordance with the above instructions, and which interfered with work and equipment of other trades.

   D. In all areas where air diffusers and lighting fixtures are to be installed, the Contractor shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangements.

2. INTERFACING

   The Contractor shall insure that coordination is affected relative to interfacing of systems. Some interface points are (but not necessarily all):

   A. Connection of Domestic Water System to water service mains.

   B. Connection of Natural Gas System to natural gas service.

   C. Connection of Fire Protection System to domestic water service.

   D. Connection of Sanitary sewer house line to municipal service.

   E. Connection of Storm Drainage System to municipal system.

   F. Connection of fuel oil piping to emergency generator.

   G. Connection of Domestic Water System to Hydronic System.

H. Connection of all controls to equipment.

I. Electrical power connections to electrically operated (or controlled) equipment.

J. Connection of Emergency Engine Exhaust System.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall make all connections to equipment furnished by others, or relocated from the existing structure, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. Supervision to assure proper functioning and operation shall be provided by the Contractor.

C. Items indicated on the drawings as rough-in only (RIO) will be connected by others. The Contractor shall be responsible for rough-in provisions only.

D. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

E. The Contractor shall be responsible for coordinating to determine any and all final connections that he is to make to equipment furnished by others.

4. COORDINATION DRAWINGS AND RECORD DRAWINGS

A. COORDINATION as follows:

(1) Detailed electronic coordination drawings shall be required for this project and shall be led by the Mechanical Contractor. Refer to Division I for requirements.

(2) Coordination Drawings shall be provided on this project by each Trade (Mechanical, Fire Protection, Electrical). Drawings shall be 30 x 42 sheet size and shall be at ¼" scale and shall match the drawing setup as included in the Architectural Drawings. Refer to Division I for procedure to request electronic drawings from Architect.

(3) The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings and shall be prepared by the Mechanical Contractor. The Coordination Drawings shall indicate (1) systems above ceilings in finished areas, (2) systems supported from the structure in finished areas without ceilings, (3) systems in the mechanical rooms, and (4) all wall, roof, floor penetrations. **These drawings shall be 3-D drawings and shall be able to be reviewed with a 3-D software system such as Revit or Navisworks.**

(4) The sheet metal fabrication shop drawings shall be completed in a timely manner so as not to conflict with construction schedule and phasing plan. At the General Contractor's discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing.

(5) Pre-Coordination Meetings with all necessary trades shall occur. During these meetings,

the Contractors shall discuss locations/elevations where piping, conduits, cable trays, etc will be installed with respect to the sheet metal fabrication drawings and other trades. The sheetmetal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all conflicts can be resolved between Trades. All conflicts shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

(6) It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:

a. All ductwork including and all above ceiling equipment i.e. VAV boxes indicating appropriate maintenance access routed as indicated on the drawings. The drawings shall indicate a 3 ft. clearance zone that is unobstructed and allows access from a 2x2 ceiling tile.
b. All hydronic, plumbing, and sprinkler piping. Indicate all valves and ensure that appropriate access is provided for all valves.
c. Provide all conduits (existing or new) 2" and above. Multiple smaller conduits hung on a common trapeze hanger that is larger than 6" wide
d. All cable tray and enclosed wireway shall be indicated and shall indicate all required access.
e. All wall, roof, floor penetrations.

(7) After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to insure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall distributed electronically (on CD) to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the General Contractor, Owner, Architect and Engineer for their Records. This process shall be completed prior to starting any work.

(8) RECORD DRAWINGS - Each Contractor shall insure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on Coordination Drawings kept at the jobsite. Refer to Division I for requirements. All Coordination drawings shall be included as Record Drawings.

END OF SECTION

SECTION 23 08 00 - HVAC COMMISSIONING

1. GENERAL

   A. RELATED WORK

      1. Division 22 – Plumbing

      2. Division 26 - Electrical

   B. REFERENCES

      1. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

      2. ASHRAE Guideline 1-1996

      3. ASHRAE Guideline 0-2005

      4. ACG Commissioning Guideline – 2005

   B. DESCRIPTION OF WORK

      1. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

      2. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

2. PRODUCTS

   A. Not used.

3. EXECUTION

A. ROLES OF THE COMMISSIONING AGENCY

1. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

2. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

3. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

4. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

5. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

6. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

7. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

8. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

9. The CA will review operating and maintenance materials for HVAC systems.

10. The CA will review phasing plans as provided by the CM relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

B. SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

1. Water to Water Heat Pump
2. Dedicated Outdoor Air Units
3. Geothermal Heat Pumps
4. Exhaust Fans
5. DDC Control System
6. VAV Terminal Units
7. Chilled Heating Water Pumps

C. HVAC COMMISSIONING PLAN

1. Commissioning Team

a. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

Program Manager (PrM)
Facilities Management Division (FMD)
Commissioning Agent (CA)
Design Team (DT)
Construction Manager (CM)
Mechanical Contractor (MC)
Controls Contractor (CC)
Test and Balance Contractor (TABC)
Electrical Contractor (EC)

2. Basis of Design Document

a. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
b. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

3. Commissioning Meetings

a. Commissioning meetings will be held in conjunction with progress meetings as necessary. The CA will be on site for the CX meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

4. Resolution Tracking Forms (RTF)

a. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
b. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

5. System Verification Checklists (SVC) / Manufacturers' Checklists

a. The MC/PC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS*. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
b. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
c. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

6. Start-Up

a. Start-up of major HVAC systems will be witnessed the CA. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review

completeness of installation in conjunction with progress meetings prior to starting HVAC equipment.

b. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

7. Controls Monitoring

a. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

8. TAB Monitoring

a. The preliminary TAB report set-up will be reviewed prior to HVAC equipment start-up, in order to assure that the final TAB report format and content is acceptable.

b. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.

c. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

9. Functional Performance Tests (FPT)

a. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS* above.

b. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems

have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.

c. The Functional Performance Tests shall include HVAC and related equipment.

1. AHU's will be tested in designed operating modes. Proper operation will be verified at minimum OA, maximum OA, automatic control, and other modes, if necessary, to achieve BOD conformance.
2. Variable Air Volume terminals with and without reheats will be tested at minimum and maximum temperature set points, and under automatic control. Intermediate settings will be tested as necessary.
3. Chilled water system will be tested in designed operating modes. Proper operation will be verified at minimum loads, maximum loads, waterside economizing mode, Manual control, automatic control, and other modes.
4. Hot water system will be tested.
5. EF's will be tested for conformance to BoD.
6. Hydronic pumps will be tested under relevant operating conditions.
7. Heat Exchangers will be tested under relevant operating conditions.
8. DDC control systems will be tested as necessary.
9. HVAC systems will be tested to assure that the building as an integrated system operates properly.
10. Trend verification of systems and subsystems shall be completed prior to start of functional performance testing. CA will provide trend format to CC and discuss trend requirements in CX meetings throughout the construction phase of project.

d. Deferred Testing

1. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
2. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

e. Rescheduled Functional Performance Test

1. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, contractor shall reimburse the owner for all additional cost the owner incurs as a result of the contractor's failure

to be complete and/or to provide operating compliant systems for commissioning. Additional costs include but are not limited to additional fees charged by the architect, engineer, construction manager and commissioning agent.

2. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed for the commissioning personnel's return trip.

10. Building Turn-Over / Owner Orientation / User Training
    a. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
    b. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
    c. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going HVAC related problems are being addressed and corrected in a timely and efficient manner.
    d. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

D. RESPONSIBILITIES OF TEAM MEMBERS

1. Construction Manager (CM)

    A. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the HVAC commissioning process.
    B. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
    C. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
    D. Coordinate inclusion of commissioning activities in the construction schedule.

E. Facilitate resolution of deficiencies identified by observation or performance testing.
F. Involve CA in selection of the air balancing contractor.
G. Assist the CA in monitoring the duct leakage testing.

2. Mechanical Contractor (MC)

A. Each contractor in this division shall include in their quote the cost of participating in the commissioning process.
B. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
C. Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
D. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
E. Attend commissioning meetings scheduled by the CA.
F. Assist the CA in system verification and performance testing.
G. Prepare preliminary schedule for HVAC system inspections, O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CA. Update schedule as appropriate throughout the construction period.
H. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
I. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
J. Notify the CA a minimum of two weeks in advance of scheduled system start-up.
K. Update drawings to as-built condition and review with the CA throughout the construction process.
L. Schedule vendor and subcontractor provided training sessions as required by project specifications.
M. Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.

1. HVAC equipment including fans, air handling units, dehumidification units, ductwork, dampers, terminal devices, etc.
2. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
3. That BAS is functioning in accordance with design intent.

N. Participate in the Functional Performance Tests.
O. Participate in the off-season mode testing.
P. Participate in O&M Training as required by project specifications.
Q. Provide a complete set of as-built drawings and O & M manuals for review. The CA shall review the as-built drawings and O&M manuals concurrently with the design team.

3. Test and Balance Contractor (TABC)

A. Include cost for commissioning requirements (participation) in the contract price.
B. Attend commissioning meetings scheduled by the CA.
C. Submit the TAB procedures and preliminary TAB report to the CA for review at least two weeks prior to beginning TAB work.
D. Notify the CA a minimum of two weeks in advance of scheduled TAB work.
E. Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CA.
F. Assist the CA in system verification and performance testing.
G. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
H. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CA for verification or diagnostic purposes.
I. Participate in the Functional Performance Tests as required to achieve design intent.
J. Provide sound and vibration where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.
K. Participate in the off-season mode testing as required to achieve design intent.
L. Participate in O&M Training as required by project specifications.

4. Temperature Control Contractor (TCC)

A. Include cost for commissioning requirements in the contract price.
B. Review control sequence and component selection for conformance with design intent.

1. Attend a submittal review meeting with the CA and Engineer to ensure clear understanding of scope of work and expectations.
2. Verify that specified safeties and interlocks have been selected.
3. Verify proper selection of control valves and actuators based on design parameters.

4. Verify proper selection of control dampers and actuators based on design parameters.
5. Verify that sensor selection conforms to design intent.

C. Attend commissioning meetings scheduled by the CA.
D. Provide the following submittals to the CA:

1. Hardware and software submittals.
2. Control panel construction shop drawings.
3. Narrative description of control sequences for each HVAC system and subsystem.
4. Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.
5. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
6. A complete listing of all software routines employed in operating the control system. Also provide a program narrative that describes the logic flow of the software and the functions of each routine and sub-routine. The narrative should also explain individual math or logic operations that are not clear from reading the software listing.
7. Hardware operation and maintenance manuals.
8. Application software and project applications code manuals.
9. Panel and equipment insert documents.
10. Assist CA with remote monitoring capabilities. Supply any software and/or hardware needed.

E. Verify that specified interfaces provided by others are compatible with BAS hardware and software.
F. Coordinate installation and programming of BAS with construction and commissioning schedules.
G. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
H. Provide control system technician to assist during equipment startup.
I. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
J. Participate in the Functional Performance Tests as required by the project specifications.

K. Provide a control system technician to assist during verification and performance testing.
L. Provide system modifications to achieve system operation as defined by the design intent.
M. Provide support and coordination for TAB contractor. Provide all devices, such as portable operator terminals and all software for the TAB to use in completing TAB procedures.
N. Provide written notification that the TCC scope of work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent, and that BAS is functioning in accordance with design intent.
O. Participate in the Functional Performance Tests as required to achieve design intent.
P. Participate in the off-season mode testing as required to achieve design intent.
Q. Participate in O&M Training as required by project specifications. Include training on hardware operations and programming

END OF SECTION

SECTION 23 11 00 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the other trades the required locations of sleeves. Improperly located openings shall be reworked at the expense of the Contractor.

C. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go through; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at is own expense.

D. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

E. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.

F. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

2. SLEEVES, PLATES AND ESCUTCHEONS

A. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for pipes where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the pipe or conduit and the sleeves shall be made completely and permanently water tight.

B. Pipe that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

C. At all other locations either pipe sleeves or core drilled openings are acceptable.

D. Where thermal expansion does not occur, the wall may be sealed tight to the pipe or insulation.

E. Insulation, that requires a vapor barrier (i.e., cold water or refrigerant piping, etc.), must be continuous through the sleeve/cored hole. For other piping, insulation may stop on either side of the sleeve.

F. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" above finished floor level.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

H. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.

I. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

3. CUTTING

A. All rectangular or special shaped openings in plaster, stucco or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.

B. Contractors shall coordinate all openings in new and existing masonry walls with the General Contractor; and, unless otherwise indicated on the Architectural drawings, provide lintels for all openings required for the work (Louvers, wall boxes, exhaust fans, etc.). Lintels shall be sized per Structural Engineers requirements.

C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

4. PATCHING AND REPAIRING

A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.

C. Where the installation of conduit, ducts, piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

D. Where ducts penetrate fire rated assemblies, fire dampers shall be provided with an appropriate access door.

E. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.

F. Stainless steel collars shall be provided around all ducts, large pipes, etc., at all wall penetrations; both sides.

G. Where ducts, pipes, and conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to insure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

H. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

END OF SECTION

SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

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

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   2. Pressure regulators. Indicate pressure ratings and capacities.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.6 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.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.7 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
6. Mechanical Couplings:
   a. 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) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
   b. Steel flanges and tube with epoxy finish.
   c. Buna-nitrile seals.
   d. Steel bolts, washers, and nuts.
   e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.

5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

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

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

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

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

2.3 JOINING MATERIALS

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

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

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

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

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
   f. Fisher.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.

4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

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

2.5 PRESSURE REGULATORS

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

B. Service Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Actaris.
b. American Meter Company.
c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
d. Invensys.
e. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Actaris.
   b. American Meter Company.
   c. Eclipse Combustion, Inc.
   d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   e. Invensys.
   f. Maxitrol Company.
   g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

2.6 DIELECTRIC FITTINGS

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

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.
2. Description:
   a. Standard: ASSE 1079.

b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

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

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

2.7 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 incheswide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

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

B. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

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

3.4 INDOOR PIPING INSTALLATION

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

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

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

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

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

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

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

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

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

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

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

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

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

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Meters and Gages for HVAC Piping.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Sleeves and Sleeve Seals for HVAC Piping.

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Sleeves and Sleeve Seals for HVAC Piping.

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

3.5 VALVE INSTALLATION

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

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

3.6 PIPING JOINT CONSTRUCTION

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

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

C. Threaded Joints:
1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Hangers and Supports for HVAC Piping and Equipment.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Identification for HVAC Piping and Equipment for piping and valve identification.

3.10 PAINTING

A. Comply with requirements in Exterior Painting and Interior Painting for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
1. Alkyd System: MPI EXT 5.1D.
a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (gloss).
d. Color: Yellow.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Cast-in-Place Concrete.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 DEMONSTRATION

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

3.14 OUTDOOR PIPING SCHEDULE

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

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

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

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with steel welding fittings and welded joints.

3.17 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. One-piece, bronze ball valve with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. One-piece, bronze ball valve with bronze trim.

END OF SECTION

SECTION 23 12 00 – HYDRONIC EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall include all excavating, filling, grading, and related items required to complete his work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.

   C. Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2-0" to the side. Electric and fuel lines shall always be placed in a separate trench. All exterior lines shall have a minimum earth cover of thirty (30) inches to top of pipe, unless otherwise indicated.

   D. Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be encased for a distance not less than 5 feet on either side of the point of crossover.

2. SUBSURFACE DATA

   A. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavating to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating. This paragraph is written to include the removal of all rock with no extras, whether rock is indicated or not.

3. BENCH MARKS AND MONUMENTS

   A. Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

   A. Excavate trenches of sufficient width for proper installation of the work. When the depth of backfill over sewer pipe exceeds 10 feet, keep the trench at the level of the top of the pipe as narrow as practicable. Trench excavation for piping eight inches and smaller shall not exceed thirty inch width for exterior lines and twenty-four inch width for interior lines.

   B. Sheet and brace trenches as necessary to protect workmen and adjacent structures. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc., and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and

prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.

C. Rules and regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities discovered in the course of excavation shall be protected or relocated in accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineers. Machine excavation shall not be allowed within ten (10) feet of existing electric lines or lines carrying combustible materials. Use only hand tools.

D. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Engineer. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the Contractor's expense.

E. Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to insure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell, or flange and/or is supported with blocks or wedges will not be accepted.

F. Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper jointing of pipe. Any water pumping from this Contractor's trenches which is required during construction, shall be included in this Contract.

G. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, large trees to remain, etc. The Contractors shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be borne by the responsible Contractor.

H. Use surveyor's level to establish elevations and grades.

I. The Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation of his work.

J. The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.

K. Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm

and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Mechanical Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

5. BACKFILL AND SURFACE REPAIR

A. Backfilling for mechanical work shall include all trenches, manhole pits, storage tank pits, and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.

B. Unless otherwise indicated or specified, all piping shall be bedded on four (4) inches minimum of compacted naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve on undisturbed soil excavated as described hereinbefore. Install tracer wire above pipe. Cover the pipe with twelve (12) inches of compacted backfill to prevent settlement above and around the new pipe. The backfill shall be naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. Prior to placing this second level of backfill, apply all required coatings and coverings to pipe, apply required tests and check the grading of the pipe to insure that it is correct and that the pipe is free of swags, bows or bends. Also check lines for leaks at this point and repair as required. Once all of the preceding is accomplished, continue backfill with clean, debris and rock free earth tamped at six (6) inch intervals. Finish the backfill as specified following. Note: Water settling of backfill will be permitted only as an aid to mechanical compacting.

C. Backfill beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.

D. Backfill beneath paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill or unstable soil. Once the backfill is installed as stated above for piping, refer to 312300 for requirements.

E. Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.

F. Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.

G. Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.

H. In the absence (if not specified or indicated elsewhere in the drawings or specifications to be done by others) of such work by others, the Contractor shall lay new sod over his excavation work. Level, compress and water in accord with sound sodding practice.

I. When running any type of piping below a footer or in the zone of influence the piping shall be backfilled with cementitious flowable fill. The zone of influence is the area under the footer within a 45 degree angle projecting down from the bottom edge of the footer on all sides of the footer. Additionally, grease traps, manholes, vaults, and other underground structures shall be held away from building walls far enough to be outside of the zone of influence.

J. Warning Tape and Tracer Wire

Provide a yellow and black plastic tape in all trenches 6" above the buried utility that identifies the utility about to be encountered. For non-metallic pipe a #12 copper wire shall also be laid in the trench to aid in future location of the piping. A foil faced warning tape may be used in lieu of the plastic tape and wire.

K. All manholes, vaults, and similar underground structures shall have the top elevation set flush with finished grade unless specifically noted otherwise.

6. MINIMUM DEPTHS OF BURY (TO TOP OF PIPE)

In the absence of other indication, the following shall be the minimum depth of bury of exterior utility lines. (Check drawings for variations).

A. Geothermal Lines ..... 42 inches.

END OF SECTION

SECTION 23 13 00 –MECHANICAL PIPE, PIPE FITTINGS AND PIPE SUPPORT

GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineers. All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

C. All pipe shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted. Spacing of pipe supports shall not exceed eight feet for pipes up to 1-1/4 inches and ten feet on all other piping. Small vertical pipes (1 inch and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. (Refer to Specifications Section entitled INSULATION-MECHANICAL). In metal buildings, support piping with standard pipe hangers with C-clamp connection to main structural members (not perlins), use angle steel cross pieces between main structural members where required to provide rigid support.

D. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation.

E. In general, piping shall be installed concealed except in Mechanical, Janitor Rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur they shall be kept as close to walls as possible.

F. Installation of pipe shall be in such a manner as to provide complete drainage of the system toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be 1/2" size gate type with 3/4" hose thread end and vacuum breaker. Label each drain valve.

G. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing; if in doubt, consult Engineer.

H. Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and sound practice.

I. Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineers.

J. Nipples shall be of the same material, composition and weight classification as pipe with which installed.

K. Apply approved pipe dope (for service intended) to all male threaded joints. Pay particular attention to dope for fuel gas lines. The dope shall be listed for such use.

L. High points of closed loop hot water heating systems shall have manual or automatic air vents as indicated or required unless automatic air vents are specifically indicated. Pipe to suitable drainage point.

M. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.

N. Provide expansion joints where shown on the plans and where required by good practice. Expansion joints shall be guided and anchored in accordance with the recommendations of the Expansion Joint Manufacturer's Association.

O. Where plastic pipe penetrates a fire rated assembly, it shall be replaced with a metal threaded adapter and a metal pipe per code.

P. Where piping penetrates interior or exterior walls, the wall shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

Q. All piping to hydronic coils shall be full size all the way to the coil connection on the unit. If control valve is smaller than pipe size indicated, transition immediately before and after control valve. Also, if coil connection at unit is a different size than the branch pipe size indicated, provide transition at coil connection to unit. On 3-way valve applications, the coil bypass pipe shall be full size.

2. UNIONS AND FLANGES AND WELDED TEES

A. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. Gaskets for steam piping systems shall be flexitalic spiral wound type. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

B. Dielectric insulating unions or couplings shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.

C. Tee connections for welded pipe shall be made up with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller.

3. SPECIFICATIONS STANDARDS

All piping and material shall be new, made in the United States and shall conform to the following minimum applicable standards:

A. Steel pipe; ASTM A-120, A-53 Grade A, A-53 Grade B.

B. Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.

C. Cast iron screwed fittings; ASA B16.4.

D. Welding fittings; ASA B16.9.

E. Cast brass and wrought copper fittings; ASA B16.18.

F. Cast brass drainage fittings; ASA B16.23.

G. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.

4. PITCH OF PIPING

All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

A. Condensate Drain Lines From Cooling Equipment:

Not less than 1/4 inch per foot in direction of flow.

B. All Other Lines:

Provide ample pitch to a low point to allow 100 percent drainage of the system.

5. APPLICATIONS

A. General Notes

(1) Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.

(2) Plastic piping or any materials with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.

B. Hydronic Piping (Hot, Chilled, Dual Temperature to OA Unit)

(1) 2" and Smaller: Schedule 40 black steel pipe with screwed fittings or Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

(2) 2-1/2" and Larger: Schedule 40 black steel pipe with 125# welded or flanged joints. Weldolets may be used for branch line connections to pipe mains. Type "L" hard copper piping with wrought copper fittings and 95/5 solder may be installed.

(3) Schedule 40 Victaulic or approved equivalent mechanical grooved pipe couplings and fittings with 125# rating minimum may be used. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 220°F water temperature. Mechanical grooved piping may not be used if system water temperature exceeds 220°F.

(4) Special Notes:

a. Dielectric unions shall be provided at all connections of dissimilar materials.

b. Copper and steel piping shall not be mixed in the mechanical room.

c. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.

d. Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

C. Air Vent Discharge Lines

Type "L" soft copper; wrought copper fittings, 95/5 solder.

D. Refrigerant Piping

ACR copper tubing with forged or wrought copper fittings and silver soldered joints. Solder must have a minimum of 15% silver content.

(1) General Installation Notes:

a. Contact Engineer 24 hours prior to installation of refrigerant lines or evacuation of refrigerant system.

b. Refrigerant lines installation must meet HVAC equipment manufacturer's recommendations.

c. While installing or soldering refrigerant lines, system must continuously be purged with nitrogen.

d. After system is installed, the refrigerant system must be evacuated to 25 microns for eight hours.

E. Condensate Drain Lines

(1) Type "DWV" copper, wrought copper, lead free solder.

(2) Schedule 40 PVC with solvent welded fittings.

F. Geothermal Interior Piping(GS, GR and HPS, HPR)

a. Mains and branches – Piping shall be virgin polyethylene with a PE 3408 piping formaulation and 345464C or greater cell classification. Pipe shall be SDR 15.5, minimum pressure rating of 110 psi at 73.4°F.

b. Branches - Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

c. Transitions from polyethylene to copper – refer to detail on drawings. **Factory manufactured transition required** with brass threads. No metal threads shall be inserted into polyethylene piping, and no polyethylene threads shall be inserted into metal piping.

d. The only acceptable method for joining pipe is by a heat fusion process. Pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures. Installers shall have heat fusion school certification per geothermal specifications. Provide copy of heat fusion card to Engineer for review.

e. Within the main pump room, Schedule 40 Victaulic or approved equivalent mechanical grooved pipe couplings and fittings with 125# rating minimum may be used. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 220°F water temperature. Mechanical grooved piping may not be used if system water temperature exceeds 220°F.

f. Special Notes:

1) Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

(2) Special Notes:

a. Copper and steel piping shall not be mixed in the mechanical room.

b. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.

c. Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

G. Geothermal / Heat pump loop piping (Exterior)

a. HDPE. Refer to separate specification section 201320.

H. Hydronic Fill Lines

a. For fill lines fed by the plumbing system, piping shall be same as specified for the domestic water piping until it connects to the hydronic system.

END OF SECTION

SECTION 23 13 20 - GEOTHERMAL (EARTH COUPLED) LOOP PIPING SYSTEM

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. INSTALLATION PERSONNEL AND TRAINING REQUIRED

   A. The loop installer, must have a current International Ground Source Heat Pump Association (IGSHPA) certification, having completed an IGSHPA training course in the fundamentals of design, installation, and operation of ground source systems, and having passed the IGSHPA certification examination.

   B. Ground heat exchanger fabricators must have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of a IGSHPA Certified Heat Fusion Technician. The Fusion Technician must be thoroughly familiar with heat fusion procedures, and have had formal training at a heat fusion school under direct supervision of an IGSHPA certified instructor.

   C. Local and state laws, ordinances, and regulations as they pertain to buried pipe systems shall be strictly followed.

3. GROUND HEAT EXCHANGER MATERIALS

   A. Piping shall be virgin polyethylene with a PE 4710 piping formulation and cell classification of 445576C or E per ASTM D 3350. Pressure ratings are at 73.4° F.

   B. 2" and smaller shall be SDR 9. Pressure rating of 255 PSI.

   C. 3" and larger shall be SDR 15.5 or Schedule 40. Pressure rating of 135 PSI.

   D. Markings

      (1) Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard.

      (2) Piping shall also have permanent factory length markings.

   E. Certification

      (1) Manufacturer shall supply a notarized document confirming compliance with the above standards.

   F. Manufacturers

      (1) Centennial Plastics, Charter Plastics, Flying W Plastics, Lamson Vylon Plastics, Chevron Phillips, or Polypipe.

G. Warranty

(1) Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance. This applies to all pipe, fittings, transitions, valves, etc.

4. PIPE JOINING METHODS

A. The only acceptable method for joining buried pipe systems is by a heat fusion process.

B. Polyethylene pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures.

C. Factory installed "U" bends shall be used at the bottom well bend.

5. CASING

A. Casing shall be steel. PVC casing is not acceptable.

B. The Contractor shall include in the bid an allowance for 30 feet of permanent left-in-place steel casing per each new geothermal well indicated on the drawings. Provide a unit price per linear foot of additional casing. The actual amount of casing used per hole shall be tracked with a casing log and wellfield schematic. Schematic shall depict geothermal wells and provide labels for each. Log shall state the bore hole number (as depicted on the schematic), date and time casing was installed, and linear feet of casing left in place for **each** bore hole. For example:

Bore hole # 1	8/1/09	2 P.M.	30 feet of casing installed
Bore hole # 2	8/2/09	9 A.M.	10 feet of casing installed

This log shall be kept current at all times and be **signed daily during drilling** by the well field installer, mechanical contractor, General Contractor and Owner's representative.

C. Contractor shall submit a unit price for steel casing left in place on the Bid Form.

D. The casing log and the submitted casing unit price will be used to reconcile the Contract Amount with the actual amount of casing installed. The Contractor will only be paid the full unit price for casing left in place. Push and pull casing (temporary casing) will be paid at half the rate for casing left in place.

6. FLUSHING, PURGING, PRESSURE AND FLOW TESTING

A. General

(1) Coordinate this section with the cleaning and flushing listed in Section 234200 - HVAC Equipment.

(2) All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage.

B. Pressure Testing

(1) Vertical loops shall be pressure tested before installation. All horizontal components of the ground heat exchanger will be flushed, pressure and flow tested prior to backfilling. Pipes must contain fluid under pressure during backfilling.

(2) Heat exchangers shall be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure if this value is the smaller of the two. No leaks shall occur within a 48 hour period. Engineer shall be notified when system is to be placed under pressure test.

C. Flushing and Purging

(1) Notify the Engineer a minimum of 2 weeks in advance of system flushing. The Engineer, Mechanical Contractor, Heat Pump Supplier, Test and Balance Contractor, and Well Field Installer shall all be present to observe system flushing and purging. Schedule the system flushing to occur the same day as a regularly scheduled progress meeting. The Engineer MUST BE PRESENT. Failure to notify the Engineer in advance will result in the Contractor having to flush the system a second time.

(2) Flow rates shall be compared to calculated values to assure that there is no blockage or kinking of any pipe. Submit this in writing to the Engineer. Balance Contractor to verify.

(3) A minimum velocity of 3 ft/sec in each piping section must be maintained until all air is removed. Piping 8" and larger shall be purged at 4 ft/s minimum. The system shall also be forward and reverse flushed to remove all debris. The building shall be flushed in sections as required to maintain high velocities. Building mains shall be flushed separate from branches to maintain high velocity when flushing the mains.

(4) Final purging of air from the entire building and loop field shall be performed by the Well Field Installer so that air in building piping will not be transferred to the well field.

(5) The Balance Contractor must witness and confirm all pressure tests and flushing velocities along with confirm pressure drop for each geothermal well zone.

(6) Contractor shall provide full size connection ports and valves as required to purge wellfield and building separately.

(7) After the heat pump bypasses are flushed and the piping network is determined to be clean and free of air, the heat pumps themselves shall be flushed.

(8) The system flushing device shall be equal to a Purge Pro Max distributed by Geothermal Supply Company. The flushing pump shall provide performance equal to or exceeding the following values: 550 GPM at 117 PSI, dead head pressure of 128 PSI. SUBMIT PUMP CURVE to Engineer for review and approval prior to system flush. The flushing device shall provide means to release entrained air to the atmosphere and shall filter the water. Filter shall be 50 micron. Water shall be circulated and filters shall be changed until debris is no longer visible on filter. Contractor shall provide filter media as required.

(9) The Geothermal Piping System consists of two (2) loops required separate flushing. Building loop shall be flushed and geothermal loop shall be flushed. Two loops are separated and valves provided at primary secondary header (PSH-1).

7. HORIZONTAL PIPING SYSTEMS

A. Sharp bending of pipe around trench and bore hole corners must be prevented by using a shovel to round corners. Manufacturer's procedures must be followed.

B. Backfilling procedure will include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling, backfilling through a coarse screen for a 6 inch cover, or use of a 6 inch cover of rock-free soil. Clods resulting from use of a backhoe must be broken up so as not to form air pockets around the pipe which will reduce heat conduction between the earth and the pipe. The flow of backfill soil must be controlled to prevent bridging and the formation of air pockets. Several slow passes with an angled backfill blade are required. Flooding is required to assure removal or air pockets. Since most of the horizontal piping is below the parking lot, the backfill shall support the expected bus traffic. Backfill load bearing capacity shall meet the Architect's specification.

C. Horizontal return bends must be backfilled by hand to properly support the pipes and prevent kinking.

D. All horizontal piping shall be a minimum of 42 inches below finished grade.

8. BORE HOLE

A. The Contractor shall bore wells of a sufficient diameter to allow installation of the piping and U-bend, but shall be no less than 4-1/2".

B. The entire bore shall be grouted as recommended by IGSHPA with a thermally enhanced grout mixture with a thermal conductivity of 1.00 Btu/hr-ft-˚F. Grout shall be GeoPro Thermal Grout Lite 100 bentonite mixture or approved equal. Mixture shall be field mixed in strict accordance with manufacturer’s recommendations. Grout mixture shall be mechanically pumped with a positive displacement pump into bore hole from bottom to top utilizing a tremie tube. Through the course of the project, three sample grout specimens shall be taken of the mixed grouting material by this contractor. An analysis shall be performed by the grout manufacturer to verify proper thermal performance and grout mixture. This contractor shall submit these reports to the Owner, Architect and Engineer to verify compliance with the installation specifications.

C. If large water seams are encountered, bridging across water seams with #7 or #9 rock, or GeoPro Black Hills 3/8 inch Bentonite Plug, is acceptable. The maximum height of the rock or bentonite bridge shall not exceed 8 feet. The remainder of the vertical bore hole shall be grouted per the above specification. Bore holes with water seams shall be monitored for settling of grout. After a period of one week, all holes shall be topped off with grout as needed. The Contractor shall continue to monitor holes that experience grout settling and continue to top off with grout throughout the warranty period. Bore holes that are unable to hold grout shall be replaced with new bore holes at no cost.

D. The Contractor shall accept the site as-is and is responsible for any and all required casings. If an area of voids is encountered, the Contractor shall either fill or re-drill wells in an approved area and extend piping to them.

E. No night drilling will be allowed.

9. DUST CONTROL

A. The Contractor is responsible for and shall provide dust control. Dust shall not be allowed to leave the construction site boundaries, and furthermore, shall not be allowed to enter the building or accumulate on the building exterior. When needed to meet these requirements, the Contractor shall provide and operate a mechanical dust collection system to control dust at the source. Mechanical dust collection system shall consist of collection hood at the source ducted to a dust collector which separates dust from the airstream. Dust shall be collected into sealed containers for disposal by the Contractor.

B. Water spraying may be used but shall not be considered a substitute for mechanical dust collection at the source when required.

10. SURFACE WATER / MUD / SLURRY CONTROL

A. The Contractor is responsible for and shall provide control of all ground flowing fluids resulting from drilling operations. The Contractor shall erect silt fences or other structures as required to contain drill cuttings, mud, slurry, etc. within the construction site boundaries. In the event this requirement is not met, the Contractor shall provide all remediation measures as required by all authorities having jurisdiction over such events.

11. WARRANTY

A. The entire ground loop system and backfill from a point 5 feet inside the building shall be warranted for **five (5) years** from date of substantial completion against any leakage or failure. Warranty service for a pipe leak shall include recharging system with heat transfer fluid as originally specified, including glycol or ethyl alcohol if originally specified, as well as corrosion inhibitors.

12. BALANCE

The Contractor shall assist the Balance Contractor in balancing the geothermal well zones to obtain the specified flows.

13. SUBMITTALS

A. Submit manufacturer's specification sheets and installation instruction for each component of the system, showing manufacturer, pipe or tube weight, pressure rating, fitting type and joint type for each piping system.

B. Submit manufacturer's mechanical data for valves.

C. Submit a drawing indicating the system layout and pipe sizes.

D. Provide a copy of the technician's certification, and International Ground Source Heat Pump Association Certification.

14. TEST BORES

A. Typical test bore is provided on the plans.

B. The Contractor may visit the site prior to bid and perform their own test boring if additional information is required. This shall be coordinated with the Owner.

END OF SECTION

SECTION 23 21 00 – MECHANICAL VALVES AND COCKS

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing cocks, air cocks, lubricated plug cocks, packed plug cocks, special valves for special systems, etc., for all Mechanical Systems.

C. All valves shall be designed and rated for the service to which they are applied.

D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.

E. Ball valves with temperature and pressure ports are not an acceptable alternative to the balancing valves specified herein. Valves that do not comply with these specifications shall be removed and replaced by the Contractor with no increase in contract price.

F. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts.

G. All valves shall comply with current Federal, State and Local Codes.

H. All valves shall be new and of first quality.

I. All valves shall be full line size. Valves and hydronic specialties shall not be reduced to coil or equipment connection size. Size reductions shall be made at the connection to the equipment.

J. All valves for use in potable water systems shall comply with federal lead free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. LOCATION OF MAINTENANCE VALVES

Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

A. At each air handling unit, and make–up air unit.

B. At each heat pump.

C. At each heating or cooling coil.

D. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to insure tightness against leakage for service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.

4. TYPES AND APPLICATION

A. GATE VALVES

Gate Valves shall be of the wedge disc type, permit straight line flow, complete shut-off and designed so that when the valve is wide open, it can be packed under pressure. Valves 1-1/2 inches and smaller shall be bronze, with ends to suit piping and non-rising stem. The valve shall have a deep stuffing box for long contact with the stem, packing gland and filled with high quality packing. Valves 2 inches thru 4 inches shall be iron body bronze mounted with flanged ends and non-rising stem. Boiler stop valves and valves larger than 4 inches shall be iron body bronze mounted flanged ends with outside screw and yoke with rising stem. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 2" and under NIBCO T133, greater than 2" NIBCO F619. All gate valves 2” and smaller for use in potable water systems shall meet federal requirement to be lead free containing less than 0.25% lead by weight of wetted area. NIBCO F768B.

B. GLOBE VALVES

Globe Valves shall permit control of flow rate from full flow to complete shut-off and designed that when the valve is wide open it can be repacked under pressure, and have a deep stuffing box with gland and filled with high quality packing. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping union bonnet, and with stainless steel plug type disc and seat of not less than 500 Brinnell hardness. Valves 2 inches and larger shall be iron body bronze mounted with flanged ends, yoke bonnet, and disc guide. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 1-1/2" and under NIBCO T256AP, greater than 1-1/2" NIBCO F768B.

C. CHECK VALVES

Check Valves shall be horizontal swing type with two piece hinges, disc construction seats to be bronze and bronze discs or with composition face depending on service and provide silent operation. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping, have full area "Y" pattern body and integral seats. Valves 2 inches and larger shall be iron body brass mounted and with flanged ends. Working pressure for bronze valves shall be 150 psi and iron valves 125 psi when installed in

piping with system pressures up to 100 psi and 250 psi for 100 psi and over. 3" and under NIBCO T433Y, greater than 3" NIBCO F918B (for less than 100 psi systems) greater than 3" NIBCO F968B (for 100 psi or greater systems).

D. BALL VALVES (NON-POTABLE)

Ball Valves shall have removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blow out proof stem, bronze body, reinforced Teflon seats, chrome plated steel ball as manufactured by Consolidated Valve Industries, Inc., Lunkenheimer, Apollo, Jenkins, Nibco or equivalent. Provide a stem extension so that the base of the handle is 1/4" above the insulation. NIBCO T5800-70.

E. BALL VALVES (POTABLE WATER)

All valves for use in potable water systems 2" and smaller contain less than 0.25% lead by weight and comply with federal lead free potable water requirements. Ball valves shall have a removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing boxring, blowout proof stem, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Appollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that they bas of the handle is ¼" above the insulation. NIBCO S-585-66-LF.

F. BUTTERFLY VALVES

Butterfly valves shall be line sized cast iron body, lug style, 200 PSI rating (bubble tight) EPT or Viton seat, cartridge type; high strength stem. Disc to have ground and polished seating surface. Operator shall be locking lever style. Quality equivalent to Crane Monarch series. 3" and under NIBCO LD3222-3, greater than 3" NIBCO LD322-5.

G. BALANCING VALVES

Bell & Gossett, Model CB circuit setter balancing valve or approved equivalent. Calibrated balancing valve shall have flanged connections suitable for 125# working pressure at 250°F. 4" and up shall be rated at 175# at 250°F working pressure. Provide with brass readout valves fitted with an integral EPT insert and check valve. Each balance valve shall have a calibrated nameplate to assure specific valve settings and be constructed with internal seals to prevent leakage. **Note: Refer to Specification Section 234200-HVAC Equipment for automatic flow control balancing valves on terminal equipment.**

H. AIR COCKS

Straight nose; Lunkenheimer Fig. 476; bronze; tee handle; bent nose; Lunkenheimer Fig. 478, 125#; bronze; tee handle.

I. GAUGE COCKS

Straight, Lunkenheimer, Fig. 1178; 125#; bronze; tee handle. FIP.

J. LUBRICATED PLUG COCKS

2" and under; Homestead Fig. 601; 150#; semi-steel; screwed; 2-1/2" and over; Homestead Fig. 602; ±50#; semi-steel; flanged.

K. PACKED PLUG COCKS

2" and under; DeZurik Fig. 425-S; 175#; semi-steel; screwed. 2-1/2" and over; DeZurik Fig. 425-F; 175#; semi-steel; flanged.

END OF SECTION

SECTION 23 21 10 - ACCESS TO VALVES, EQUIPMENT, FILTERS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. All mechanical equipment shall be installed in a manner which allows ready access to all components requiring service, adjustments, shutoff, etc.

   C. Filters shall be accessible, removable and replaceable without disconnecting mounting brackets, piping, wiring, etc.

   D. Provide access doors or panels for all equipment, valves, dampers, filters, fire dampers, etc. in concealed spaces not otherwise provided with suitable access. (Lay-in ceilings shall be considered acceptable access; splined or drywall ceilings shall not).

   E. All valves, unions, strainers, cleanouts, volume dampers, and test points shall be accessible.

   F. Access panels in lay-in ceilings shall be labeled with a lamacoid plate to indicate location of equipment, filters, valves, etc.

   G. Access panels in fire rated walls shall bear the same rating as the wall.

   H. Each fire damper shall be provided access through the duct to allow reset of the damper. This may be either a gasketed sheet metal panel over a suitable opening or a factory built access panel. The panel shall be at least one and one-half (12) inch larger than the opening all around and shall be held in place with sheet metal screws sufficiently to insure that it is air tight. Manually check the size and location of each of these openings to insure that the fire damper may be manually reset by use of hand only.

2. ACCESS DOORS

   Refer to Sheet Metal and Flexible Duct section of the specifications.

END OF SECTION

SECTION 23 22 00 - INSULATION - MECHANICAL

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.

   C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

   A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or other approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

   A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.

   B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.

   C. All products and their packaging shall bear a label indicating above requirements are not exceeded.

   D. Duct linings shall meet the Erosion Test Method in compliance with UL Publication No. 181.

4. GENERAL APPLICATION REQUIREMENTS

   A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.

   B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork is to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No

noticeable deformation of insulation or discontinuity of vaporseal, where required, will be accepted.

C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.

E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!

F. All insulation shall be installed with joints butted firmly together.

G. The Contractor shall insure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

5. PIPING SYSTEMS

A. GENERAL

(1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.

(2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to ensure no condensation drip or collection.

(3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.

(4) Valves, flanges and unions shall be insulated where the piping is insulated.

(5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

(1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180 degree arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket approved manufacturers are listed in section 2. Manufacturers. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers' recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

(1) Hydronic System Fill Lines From Domestic Cold Water - 1/2" thick.

(2) Dual Temperature (Hot-Chilled) or Chilled Hydronic Water

Owens Corning Vapor Wick Insulation System including wicking pipe wrap and cellular glass pipe insulation and jacket.

Install in strict accordance with manufacturer's recommendations:

a. Piping 1 ½'' or less – use 1 ½'' thick insulation.

b. Piping 2" or larger – use 2" thick insulation

(3) Condensate Drain Lines.

a. Piping 1 ½'' or less – use 1/2" thick insulation

b. Piping 2'' or greater – use 1'' thick insulation

(4) Geothermal Interior Piping (GS, GR and HPS, HPR)

a. HDPE piping mains – use 1/2" thick insulation
b. Copper branch piping - use 1/2" thick insulation

(5) Refrigerant Liquid and Suction Lines - Interior & Exterior

IMCOA, Nomaco, or Armacell closed cell polyethylene, 1.5 Lbs/Ft^3 density, 0.24 BTU-Hr.-Ft^3-°F/in at 75°F thermal conductivity, zero vapor permeance, 25/50 flame and smoke spread

per NFPA 90 requirements. Elastomeric closed cell insulations that meet the above requirements are also allowed. Install insulation per the manufacturer's requirements. Provide UV protective coating for all exterior refrigerant lines.

a. All pipe sizes: 1 ½'' thick

D. JACKETS

(1) Exposed (Mechanical Rooms, Interior Finished Rooms and Storage Rooms)

All insulated piping installed in the above areas shall have a canvas or PVC jacket:

a. 6 oz. canvas jacket with fire retardant lagging. Apply to the insulation specified for the piping. In Heat pump closets, the canvas jacket shall only be installed up to 7' above finished floor. In the main pump room where the geothermal piping enters and exits the building, all exposed piping shall be canvas wrapped.

b. For all systems except steam, plenum rated PVC jacket equal to LoSmoke PVC jacket with flame/smoke rating of 25/50, ASTM-E84 test method. Minimum thickness 0.04 inches. Steam systems shall utilize plenum rated CPVC jacket with minimum thickness of 0.04 inches. Jackets shall be applied over top of specified pipe insulation. Approved equal manufacturers are Zeston and Speedline. Approved equal manufacturers are Zeston and Speedline.

6. DUCTWORK SYSTEMS

A. GENERAL

(1) Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.

(2) Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to insure no condensation drip or collection. The backs of all supply diffusers, plenums, grilles, etc. shall be insulated only if indicated by details on the drawings.

(3) All flexible duct connections on insulated ductwork shall be externally insulated.

(4) All duct outside of building envelope, including rooftop duct, duct in unconditioned attic spaces above the insulation, etc. shall have two layers of specified insulation. This shall apply to supply air, exhaust air where air is run through energy recovery unit, outside air, return air, and combustion air intake ducts.

B. EXTERNAL INSULATION

(1) Supply Air
(2) Outside Air From OA-1 to Intake Louver
(3) Exhaust Air From OA-1 to Exhaust Louver

Owens/Corning “Faced Duct Wrap - Type 100", or approved equal, 2" thick fiberglass duct wrap, **1.0 pcf** density factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch. K factor shall not exceed .26 at 75°F. mean temperature. Minimum R-value of the 2” thick insulation shall be 7.4 out of package and 6.0 installed.

7. MECHANICAL EQUIPMENT

A. EXPANSION TANK, COMPRESSION TANK, AIR SEPARATOR, SIDESTREAM/LOOP FILTERS, AND WATER STORAGE TANKS FOR DUAL TEMPERATURE LOOP

(1) Owens-Corning "Tank Wrap I" or approved equivalent. Insulation shall be constructed of non-combustible, flexible wool. Insulation shall be 2" thick. K factor shall be .29 at 100°F. mean temperature. Insulation shall be attached in strict accordance with the manufacturer’s recommendations. All insulation shall be jacketed with 6 oz. canvas with fire retardant lagging. Coordinate with mechanical contractor to extend all piping connections, blowdown ports, etc. outside of the insulation. Additionally for loop filters and other equipment requiring periodic service, provide removable insulated covers.

END OF SECTION

SECTION 23 23 00 - THERMOMETERS & OTHERS, MONITORING INSTRUMENTS

1. GENERAL

   A. The Contractor shall include all thermometers, pressure gauges and/or compound gauges at the locations indicated.

2. THERMOMETERS AND PRESSURE GAUGES

   A. All thermometers and gauges shall be readable from a standing position on the floor.

   B. Thermometers shall be linear, alcohol filled, graduated in 1°F. Or less and shall have adequate range for service intended.

   C. Pressure gauges shall be Bourdon Type, circular, 3" face, black letters on white face graduated in 2 PSI or less and shall have adequate range and shall be manufactured for service intended. Provide with pig tail connectors and gauge cocks.

   D. Pressure gauges and thermometers subject to vibration shall be mounted remotely away from vibrating pipe surface, etc., with flexible tubing.

   E. Mount thermometers in approved wells and install with thermal grease. Do not make direct contact of base with fluid in pipe.

   F. Gauges and thermometers shall be Marsh, Marshalltown, Weksler or equivalent.

3. Provide, when indicated on the plans, on the inlet and outlet of each terminal unit, a “Pete’s Plug” or equivalent pressure/temperature test station. Furnish two (2) matching thermometers and pressure gauges to the owner upon project completion.

END OF SECTION

SECTION 23 24 00 – IDENTIFICATIONS, TAGS, CHARTS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. VALVE TAGS AND CHARTS

   A. Provide and install on each valve in the Mechanical Systems a 1-1/2" diameter circular brass tag fitted to each valve so that it cannot be removed. Each tag shall be embossed consecutively with letter and number identifiers as to system and purpose respectively. Letter identifiers shall be as follows:

DTS/DTA	Dual Temperature
HPS/HPR	Heat Pump Supply/Return
GS/GP	Geothermal Supply/Return
RF	Refrigerant

   Number identifiers shall be determined by the Contractor sequentially. For example, valve No. HC-1 may be maintenance stops for fan coil units. HC-2 maintenance stops for air heaters, etc.

   B. Provide three (3) copies of typewritten valve charts indicating each valve identifier, the valves purpose and its location. For example: "HC-1 Fan Coil Maintenance Stop-one valve at supply and return of each fan coil unit." One (1) copy of this chart shall be mounted in suitable wood frame(s) with clear plastic or glass covers in a conspicuous location in the Mechanical Room. Two other copies shall be turned over to the Engineers.

   C. Where more than one major Mechanical room is indicated for the project, install mounted valve schedule in each major Mechanical Room, and repeat only main valves which are to be operated in conjunction with operations of more than single Mechanical Room.

3. PIPING IDENTIFICATION

   A. GENERAL

      (1) All exposed piping installed shall be identified according to the color coding chart hereinafter specified. In addition, provide stenciled markers and arrows indicating direction of flow on all piping installed under this Contract after the piping has been painted. Markers and arrows shall be painted on the piping using machine cut stencils. All letters shall be sprayed using fast drying lacquer paint. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor. At the Contractor's option, Setmark or equivalent manufactured marking system may be substituted for field marking. The following table describes the size of the color field and size of the identification letter which shall be used for pipes of different outside pipe diameters.

OUTSIDE DIAMETER OF PIPE OR COVERING	LENGTH OF COLOR FIELD	SIZE OF LETTERS
INCHES	INCHES	INCHES
3/4 TO 1-1/4	8	1/2
1-1/2 TO 2	8	3/4
2-1/2 TO 6	12	1-1/4
8 TO 10	24	2-1/2
OVER 10	32	3-1/2

(2) "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

B. PAINTING (REFER ALSO TO ARCHITECTURAL SECTION ON PAINTING)

(1) Paint exposed pipe (whether insulated or bare) where located in finished spaces.

C. All piping shall be marked. Piping shall be marked not less than every 15 linear feet above a ceiling system, every 10 feet in a mechanical room, and at all points where the piping passes through wall or floors.

D. Piping, whether exposed or concealed, shall be marked not less than every 15 linear feet and at the points where the piping passes through wall or floors.

4. EQUIPMENT IDENTIFICATION

A. All equipment, except in finished rooms, shall be identified by stenciling the title of the equipment as taken from the plans in a position that is clearly visible from the floor. The letters shall be made with black paint and shall be not less than two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. Lamacoid plates are also acceptable. In finished rooms or outdoors, equipment shall be identified by engraved nameplates.

5. DUCTWORK IDENTIFICATION

A. All ductwork shall be identified as to the service of the duct and direction of flow. The letters shall be at least two inches high and the flow arrow shall be at least six inches long. The letters and flow arrow shall be made by precut stencils and black oil base paint with aerosol can. Concealed ducts need not be identified.

6. ACCESS THROUGH LAY-IN CEILINGS

A. Mark the ceiling T-bar nearest the ceiling panel access to equipment, valves, damper, filter, duct heaters, etc., with a small red lamacoid plate with name of item above ceiling.

END OF SECTION

SECTION 23 25 00 – MECHANICAL HANGERS, CLAMPS, ATTACHMENTS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. Each Contractor's attention is also directed to Section 231300, Pipe, Pipe Fittings and Pipe Support.

   C. This section includes, but is not limited to, furnishing and installing dampers, supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work.

   D. Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

2. MATERIALS AND EQUIPMENT

   A. Hangers, Clamps, Attachments, Etc.:

	SIZE	SPECIFICATION
1. Pipe Rings	2" pipe and smaller	Adjustable swivel split ring or split pipe ring, Grinnell Figures 104 and 108, Elcen, Fee & Mason, or approved equivalent.
2. Pipe Clevis	2-1/2" pipe and larger	Adjustable wrought Clevis type, Grinnell Figure 260, Elcen, Fee & Mason, or approved equivalent.
3. Pipe Clevis	All	Steel Clevis for insulated pipe, Elcen Figure 12A, Grinnell, Fee & Mason or approved equivalent.
4. Rise Clamps	All	Extension pipe or riser clamp, Grinnell Figure 261, Elcen, Fee & Mason or approved equivalent.
5. Beam Clamps and Attachments	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason, or approved equivalent. Malleable beam clamp with extension piece figure 229; I-beam clamp figure 131; C-clamp figures 83, 84, 85, 86, 87, and 88.

6. Brackets	All	Welded steel brackets medium weight, Grinnell Figure 195, Elcen, Fee & Mason or approved equivalent.
7. Concrete Inserts	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason or approved equivalent. Wrought steel insert Figure 280 and wedge type insert Figure 281.
8. Concrete Fasteners	All	Self-drilling concrete inserts, Phillips, Grinnell, Elcen or approved equivalent.
9. Ceiling	All	Grinnel Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Pipe hanger flange Figure 153, adjustable swinging hanger flange Figure 155, ceiling flanges Figures 128 and 128R, and adjustable ceiling flange Figure 116.
10. Rod Attachments	All	Grinnel Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Extension piece Figure 157, rod coupling Figure 136, and forged steel turnbuckle Figure 230.
11. U-Bolts	All	Standard, U-bolt, Grinnell Figure 137, Elcen, Fee & Mason, or approved equivalent.
12. Welded Pipe Saddles	All	Pipe covering protection saddle sized for thickness of insulation, Grinnell Figure 186, Elcen, Fee & Mason or approved equivalent.
13. Pipe Roll	All	Adjustable swivel pipe roll, Grinnell Figure 174, Elcen, Fee & Mason, or approved equivalent.
14. Protection Saddle	All	18 gauge sheet metal pipe protection saddle, Elcen Figure 219, Fee & Mason, Power Strut, or approved equivalent.
15. Hanger Rods	All	Steel, diameter of the hanger threading, ASTM A-107.

16. Miscellaneous Steel	All	Steel angles, rods, bars, channels, etc., used in framing for supports and fabricated brackets, anchors, etc., shall conform to ASTM-A-7.
17. Concrete Channel Inserts	All	Continuous slot inserts, Unistrut, or approved equivalent. Heavy duty Series P-3200 or Light Duty Series P-3300 as required.
18. Adjustable Spot Insert	All	Adjustable spot insert Unistrut, or approved equivalent, P-3245. Design load 1000 lbs.

3. INSTALLATION

A. Unless otherwise specifically indicated or hereinafter specified in the specifications, all supporting, hanging and anchoring of piping, ductwork, equipment, etc., shall be done by each trade as is necessary for completion of the work and shall be as directed in the following paragraphs:

(1) Supporting and hanging shall be done so that excessive load will not be placed on any one hangers so as to allow for proper pitch and expansion of piping. Hangers and supports shall be placed as near as possible to joints, turns and branches.

(2) For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power driven devices may be used when approved in writing by the Architect/Engineer. Utilize beam clamps for fastening to steel joists and beams and expansion anchors in masonry construction. When piping is run in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger.

(3) Trapeze hangers shall be supported by steel rods of sufficient diameter to support piping from joists or concrete construction. Where desired or required, piping may be double mounted on trapeze hangers. Where conditions permit, trapeze hangers may be surface mounted on exposed joists by means of approved beam clamps, or to concrete construction by means of approved adjustable inserts or expansion anchors.

(4) Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross steel joists.

(5) Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.

(6) Where piping, etc., is run vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum and an approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.

(7) Where piping is run along walls, knee braced angle frames or pipe brackets with saddles, clamps, and rollers (where required) mounted on structural brackets fastened to walls or columns shall be used.

(8) Support all ceiling hung equipment, with approved vibration isolators.

(9) Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.

(10) Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze and wall bracket type support shall be held in place with U-bolts. U-bolts shall allow for axial movement in the piping.

(11) All insulated piping shall be supported with clevis type and/or pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.

(12) Under no conditions will perforated band iron or steel wire driven hangers be permitted.

(13) In general, support piping at the following spacing:

a. Steel and copper piping - 5 feet intervals for piping 3/4" and smaller. 6 feet intervals for 1 ¼" and 1" pipe. 8 foot intervals for piping 1 ½" to 3". 10 foot intervals piping 3 ½" and larger.

b. Polyethylene piping – 4 foot intervals for piping 2" and smaller. 5 foot intervals for 3" pipe. 6 foot intervals for 4", 6", and 8" pipe. 7 foot intervals for 10" and larger pipe.

c. Where the manufacturer of the pipe has more strict guidelines, the manufacturer's recommendations shall be followed.

END OF SECTION

SECTION 23 31 00 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

1. GENERAL

   A. The General Conditions, Instructions to Bidders, Section 230100, and other Contract Documents are a part of this specification and shall be binding on all Mechanical Contractors. It shall be each Contractor's responsibility to apprize himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.

   B. The Engineer, or his authorized representative, shall be notified by the Contractor one (1) week in advance of any tests called for in these specifications or required by others. The Engineer will determine which of these test they will witness. Any leaks or imperfections found shall be corrected and a new tests run to the satisfaction of the Engineer or his authorized representative. Upon completion of a test, a written approval of that part of the work will be given to the Contractor. Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow his work to be furred-in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

2. HYDRONICS

   A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

   B. Water piping systems shall be subjected to a hydrostatic test of one hundred fifty pounds. The systems shall be proven tight after a twenty-four (24) hour test.

   C. Thermometers and gauges shall be checked for accuracy. If instruments prove defective, they shall be replaced.

   D. The Contractor shall perform all additional tests that may be required by the Maryland Department of Health or other governing agency.

   E. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.

3. HEATING, VENTILATING AND AIR CONDITIONING

   A. The test and balance of this system shall be by a contractor who employs only the services of a certified AABC or independent NEBB firm whose sole business is to perform test and balance services. The test and balance contractor shall report all deficiencies to the engineer.

   B. The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic

test of not less than one hundred pounds and shall be proven tight after a twenty-four (24) hour test.

C. All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating and control valves shall be adjusted. Excessive noise or vibration shall be eliminated. Provide all start-up documents to Designer prior to any test and balance services.

D. System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.

E. All fan belts shall be adjusted for proper operation of fans.

F. All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.

G. For the purpose of placing the heating, ventilating and air conditioning system in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council. The following systems shall be test and balance:

(1) The exhaust and outside air duct systems associated with OA-1. Provide static pressure profiles thru each system. Static pressure profiles shall include all sections from the outside air duct inlet and outside air outlet and exhaust air outlet and exhaust air inlet of the air handling unit. On units equipped with exhaust air fans; show location and profile of the exhaust fan.

(2) The geothermal (GS/GR) pumps.

(3) The dual temperature (DTS/DTA) pumps.

(4) Set the minimum and maximum air flow rates for each VAV and CAV box.

(5) Balance all supply, return and exhaust air grille to within 10% of design air flow rate.

(6) Balance the kitchen rangehood supply/exhaust air system.

(7) All circulator pumps serving water-source heat exchangers. Refer to drawings for location of all distributive pumping circulators.

(8) Pressure test ductwork if required by sheet metal specification section 234400.

(9) Adjust all adjustable diffusers to minimize air drafts and eliminate suspended light fixture sway. Furthermore, adjustable diffusers in spaces with ceilings taller than 9 feet shall be adjusted to eliminate air stratification during heating season.

H. Provide a preliminary test report to the mechanical engineer immediately after the system is air balanced, or any initial phases are balanced. This report may be hand written. Anticipate visiting the site again after the engineer has reviewed the report. The engineer may request up to 15

additional static pressure measurements for any air handling system to help resolve any balancing deficiencies. Include five additional static pressure measurements for each exhaust air system.

I. The Test and Balance agency shall provide lifts, scaffolding, etc. as required to balance devices in areas with high ceilings such as gymnasiums, auditoriums, atriums, cupolas, etc. The Test and Balance agency may coordinate with the General Contractor or Mechanical Contractor to arrange for these items to be provided to access high devices, however, it is emphasized the Contractor is finally responsible for providing the means required to balance all devices.

J. Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.

K. Test and Balance agency is to provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor will purchase and install all sheaves and belts as required. This includes new and existing equipment.

L. An electronic copy of the complete test reports shall be submitted to the Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.

M. The Contractor shall provide and coordinate their work in the following manner:

(1) Provide sufficient time before final completion date so that tests and balancing can be accomplished.

(2) Provide immediate labor and tools to make corrections when required without undue delay.

N. The Contractor shall put all heating, ventilating and air conditioning systems and equipment and rangehood system into full operation and shall continue the operation of same during each working day of testing and balancing.

O. Geothermal Balance

(1) Confirm flushing velocities (forward and backward) in geothermal well field.

(2) Confirm pressure drop values for each well field zone.

(3) Set flow rate for each well field zone.

(4) Submit report confirming above geothermal information to the Engineer prior to submission of final balance report.

P. Automatic Flow Control Balance Valves

(1) Verify that each installed automatic flow control device matches the GPM indicated on the drawings.

(2) Verify that the actual pressure at each automatic flow control device is within the pressure limits specified by the valve manufacturer.

END OF SECTION

SECTION 23 41 00 - PUMPS

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the specifications which affect the work of this section and which are hereby made a part of the work specified herein.

B. All required motor starters shall be furnished with the respective pump.

C. Electric motors shall be furnished with the pumps and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard.

D. Shop drawings shall be submitted as required by Section 230300 and shall include complete pump specifications, installation and start-up instructions, current and accurate pump performance curves with the selection points clearly indicated, maintenance data and spare parts lists.

E. Pumps shall be factory tested, cleaned and painted prior to shipment. Size, type, capacity and electrical characteristics are listed in the pump schedule.

F. Insofar as possible, all pumps shall be by the same manufacturer.

G. Pump shall have data plate indicating horsepower, voltage, phase, ampacity, pressure head, and flow rate.

H. Special notes for pumps controlled by variable frequency drives:

(1) Supplier shall provide the largest non-overloading impeller size for the specified pump motor horsepower, regardless of the specified pump head given on the pump schedule(s).

(2) Pumps less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

2. MATERIAL

A. BASE MOUNTED PUMPS

(1) Type: Horizontal, base mounted, end suction, single stage, flexible coupled, 175 PSI working pressure.

(2) Pump Body: Cast iron, flanged gauge and drain tappings, bronze fitted.

(3) Shaft: Stainless steel. Refer to special notes for pumps controlled by VFD's above for shaft grounding kit specification.

(4) Seal: Mechanical, carbon ring with ceramic seal.

(5) Motor: open, drip proof, re-lubricatable ball bearing. Minimum efficiency per NEMA Premium Induction Motor Efficiency.

(6) Impeller: Enclosed, balanced.

(7) Base: Structural steel.

(8) Coupling: Flexible with coupling guard.

(9) Manufacturers: Subject to compliance with the specified and scheduled requirements. Pumps by the following manufacturers will be considered:

Amtrol/Thrush
Armstrong/Aurora
Bell and Gossett
Federal Pump
Patterson
Sigmund
Worthington Pump
Weinman
Taco
FloFab
Grundfos

(10) SELECTIONS:

Refer to the schedule on the plans for base-mounted pump selections.

END OF SECTION

SECTION 23 42 00 - HVAC EQUIPMENT AND HYDRONIC SPECIALTIES

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide in complete working order the following heating, ventilation and air conditioning equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.

C. Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer’s Checklist.

D. Factory startup is required for all HVAC equipment. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. This shall include air handling units, boilers, chillers, cooling towers, VFDs, etc.

E. All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90 and/or International Energy Conservation Code 2015, whichever is more stringent.

F. Installation of all heating, ventilating and air conditioning systems shall be performed by a master HVAC contractor licensed in the state the work will be performed.

G. Note to Suppliers and Manufacturers Representative furnishing proposals for equipment for the project:

(1) Review the Controls Section of these Specifications (if applicable) to determine controls to be furnished by the equipment manufacturer, if any. The Contractor shall provide all controls with equipment unless specifically listed otherwise.

(2) Review the section of these specifications entitle: SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.

(3) Insure that the equipment which you propose to furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.

(4) Determine from the Bid Documents the date of completion of this project and insure that equipment delivery schedules can be met so as to allow this completion date to be met.

(5) Where manufacturers' temperature controls are specified, they shall be in full compliance with International Mechanical Code Section 606 including automatic smoke shut down provisions.

(6) Provide factory start-up on site by a factory representative (not a third party contractor) for all HVAC equipment, including pumps, VFDS, boilers, chillers, cooling towers, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer.

(7) Provide training to the Owner by a factory representative for each type of equipment. Training shall be a minimum of eight (8) hours on site and the Engineer shall be notified one (1) week in advance of the training. Training shall only occur when the systems are complete and 100% functional. All training shall be video taped.

(8) Review the Section on Motor Starters and Electrical Requirements for Mechanical Equipment.

(9) Requirements for motors controlled by variable frequency drives:

a. All motors shall be inverter duty rated.

b. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

(10) Equipment incorporating energy recovery wheels shall be provided with an aluminum wheel with molecular sieve desiccant, 4 angstrom maximum sieve size. Wheels shall be certified in accordance with ASHRAE 84 or ARI 1060 standards.

(11) All condensate producing equipment shall be provided with a condensate trap as recommended by the equipment manufacturer and a condensate overflow switch.

(12) Provide a complete air tight enclosure with opening door that seals air tight for all filters on air moving equipment.

(13) All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

2. EQUIPMENT

A. WATER SOURCE HEAT PUMPS

(1) Tranquility® Large (TL) 084-300 60hz

General:
Furnish and install ClimateMaster Tranquility® Large (TL) Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped, and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI / ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI / ISO and ETL-US-C labels.

All units shall pass a factory acceptance test.

Basic Construction:
Vertical Units shall have one of the following air flow arrangements: Back Return/Top Discharge, Front Return/Top Discharge, Back Return/Front Discharge, Front Return/Back Discharge as shown on the plans. Units can be field converted without requiring new panels or belts. Units that cannot be field converted shall not be acceptable.

If units with these arrangements are not used, the contractor is responsible for any extra costs incurred by other trades. All units must have a minimum of two access panels for serviceability of compressor compartment.

Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) foil backed fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Units without foil-faced insulation in the air handling section will not be accepted.

Vertical heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish on access panels. The color will be Pewter. Both sides of the panels shall be painted for added protection.

Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

Vertical units to have discharge air duct collar. Filters housings and filters to be installed separately as indicated on drawings.

All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable.

Cabinets shall have separate knockouts on front and sides for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, connections on both sides (installer to choose side and plug opposite) and shall be securely mounted flush to the cabinet side allowing for connection of a flexible hose without the use of a back-up wrench. All water connections and electrical knockouts must not interfere with the serviceability of unit. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

Provide UltraQuiet package shall consist of high technology sound attenuating material that is strategically

applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions. Compressor is mounted on specially engineered sound-tested isolators.

The unit shall be supplied with extended range Insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Fan and Motor Assembly:

All units shall have belt-driven single or dual centrifugal fans. Fan motor shall be permanently lubricated with thermal overload protection. Units supplied without a permanently lubricated motor must provide external oilers for easy service. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. Airflow / Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no air filter shall NOT be acceptable.

Refrigerant Circuit:

All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the disconnect switch. Units that cannot be reset at the thermostat shall not be acceptable.

Hermetic compressors shall be internally sprung. The scroll compressors shall have a dual level vibration isolation system. The compressor(s) will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment isolated from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be a dual port balanced type with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid

fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

Unit shall include ClimaDry® II reheat option. Only modulating reheat that will adjust capacity based upon supply air temperature to provide "neutral" (72ºF, 22.2ºC) constant air temperature will be accepted. "Neutral" supply air temperature shall be provided regardless of entering loop water temperatures or refrigerant condensing pressures. Control of reheat must be accomplished via a humidistat or dehumidistat contact closure. Refrigerant circuit must be AHRI certified. Approved equal manufacturers may provide pre-engineered integrated modulating hot gas reheat within the unit cabinet. Any design costs and costs of field installed items shall be borne by mechanical contractor. Refrigerant circuits that are not AHRI certified when the reheat option is applied will not be accepted.

Drain Pan:
The drain pan shall be constructed of galvanized steel and have a powder coat paint application to further inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow complete and unobstructed drainage of condensate. Drain pan hose assembly can be connected to either side, drain outlet to be 1" FPT fitting. Choice of drain connection to only one side will not be accepted. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches will NOT be accepted.

The unit shall be supplied with stainless steel drain pan.

Electrical:
A control box shall be located within the unit compressor compartment and shall contain a 75VA transformer with load side circuit breaker protection, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor. Two compressor units shall have a solid-state time delay relay and random start to prevent both compressors from starting simultaneously.

The unit shall be supplied with electrical disconnect.

Solid State Control System (CXM):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.
c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.

h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or anti-freeze).
p. Air coil low temperature sensing.

Provide enhanced solid state control system (DXM). This control system features two-stage control of cooling and two-stage control of heating modes for exacting temperature and dehumidification purposes.

Control shall have all of the above-mentioned features of the CXM control system along with the following expanded features:

a. Removable thermostat connector.
b. Night setback control.
c. Random start on return from night setback.
d. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
e. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
f. Dry contact night setback output for digital night setback thermostats.
g. Ability to work with heat pump or heat/cool (Y, W) type thermostats.
h. Ability to work with heat pump thermostats using O or B reversing valve control.
i. Emergency shutdown contacts.
j. Boilerless system heat control at low loop water temperature.
k. Ability to allow up to 3 units to be controlled by one thermostat.
l. Relay to operate an external damper.
m. Ability to automatically change fan speed from multistage thermostat.
n. Relay to start system pump.
o. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

Digital Night Setback with Pump Restart (DXM w/ ATP32U03/04)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM controller with an ATP32U03/04 thermostat and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period.
An additional accessory relay on the unit DXM controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel (CXM/DXM):

Solid state control system shall communicate with thermostat to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat.

Temperature controls contractor shall provide field mounted controller.

Warranty:
ClimateMaster shall warranty equipment for a period of 12 months from start up or 18 months from shipping (whichever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Thermostats shall be supplied by temperature and controls contractor, refer to 235200.

(2) Tranquility® Large Water-To-Water Model "Tmw" 360-840 Series

General:
Furnish and install ClimateMaster "TMW" Water-Source Heat Pumps as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 30° to 120°F (-1.1° to 48.9°C) as standard. All equipment listed in this section must be rated in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-2). The units shall be certified to UL508A Standard. The units shall have an UL-US-C label.

All units shall pass a factory acceptance test.

Units shall be connected to building automated system (BAS).

Basic Construction:
All units must have multiple removable panels for serviceability of compressor compartment. Service panels shall have Allen head three-quarter turn quick release latches, and hand hold pockets for easy removal.

The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection. All interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation.

Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22. Unit insulation must meet these stringent requirements or unit(s) will not be acceptable.

The frame design shall consist of heavy gauge galvanized steel with powder coat finish. The module must have a low center of gravity base with cutouts for forklift or pallet jack and the frame must be designed to fit through a standard 36 inch doorway.

Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

Unit(s) shall have exterior indicator lights showing, 1) power (on-Green), 2) unit "fault" status (fault - Red), 3) compressor 1 operation (on-Green), and 4) compressor 2 operation (on-Green).

Refrigerant Circuit:
Units shall have sealed, isolated refrigerant circuits, each including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, a reversing valve, sight glass, filter dryer, load and source brazed plate refrigerant to water heat exchangers, and safety controls including a high pressure switch, low pressure switch (loss of charge), and low water temperature sensors. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit.

Hermetic compressors shall be internally sprung. The compressors will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge base plate. Compressors shall have thermal overload protection. Each compressor shall have isolation switch to aid start-up and service.

Heat exchangers shall be highly efficient, refrigerant to water, dual circuited, brazed plate design, constructed of 316 stainless steel; designed, tested, and UL stamped in accordance with ASME Section VIII pressure vessel code for 650 PSIG (4482 kPa) working refrigerant pressure. The heat exchangers shall be mounted to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up. The heat exchangers shall be mounted on two layers of noise attenuating rubber isolation pads which also acts as a thermal barrier. The heat exchangers shall be wrapped with 3/4 inch closed cell insulated blanket and closed cell insulation shall be provided on suction side refrigerant tubing to prevent condensation.

Water Circuit:
Unit shall have all internal water tubing insulated with closed cell insulation. Field connections shall be on the top so multiple units can be installed side by side. PT ports and heat exchanger flushing connections shall be accessable from back service panel. Load and Source water shall be tested and results approved by ClimateMaster to activate unit warranty.

Unit shall have Source Motorized Valve to prevent unit from locking out when water temperature is below 60ºF in cooling mode. Valve will automatically modulate to maintain compressor head pressure, for continuous unit operation.

Unit shall have Pressure Differential Sensors for Load and Source factory installed. Sensors are for proof of water flow.

External of unit contractor must supply the following: minimum 60 mesh stainless steel screen strainers (for Load and Source), and pressure taps. All components should be isolated for ease of service.

Electrical:

The control box shall consist of a NEMA Type I enclosure with high and low voltage compartments, components include: low voltage connection block, power distribution block, compressor fusing, contactors, finger safe control fusing, transformer, isolation relays, status and alarm relay, 16-bit microprocessor DDC controller with built in native Building Automation System (BAS) communication protocols (BACnet and Modbus) two isolation switches to disable each individual compressor during start-up or troubleshooting, and external status indicating lights.

Solid State Control System:
DDC Controller shall be specifically designed to protect against building electrical system noise contamination, EMI and RFI interference. DDC control system shall be fully compatible with the Building Automation System via native BACnet or Modbus communication or BACview 6. Scheduling of the various compressors shall be performed by the microprocessor based controller. Controller shall provide following compressor safety protections: anti-short cycling, high voltage, low voltage, high discharge pressure, low suction pressure, high discharge temperature, low suction temperature, high source leaving water temperature, low load leaving water temperature, load low water flow, and source low water flow.

A compressor run time equalization sequence is provided to ensure even distribution of compressor run time. Units without even distribution of compressor run time are not acceptable. A load limit control shall be available to limit the number of compressors that can be energized at one time.

DDC Controller shall monitor and report the following for each refrigeration circuit:

a. Discharge pressure and temperature faults.
b. Suction pressure and temperature faults.
c. Compressor winding high temperature fault.
d. Low Load leaving chilled water temperature fault.
e. High source leaving water temperature fault.

DDC Controller shall monitor and report the following system parameters for the unit:

f. Chilled water entering and leaving temperature.
g. Condenser water entering and leaving temperature.
h. Load and Source low water flow.
i. Communication error
j. Electrical voltage/phase failure

Any failure condition shall cause a “fault” indication at the DDC Controller and shutdown of that compressor circuit. In the case of a system “fault” the entire unit will shutdown. When any fault occurs, the DDC Controller shall record conditions at the time of the fault, and store the data for recall. This information shall be capable of recall through BACview6 and displayed on the 4 line by 40 character, back-lit LCD. A history of faults shall be maintained including date and time for each fault (up to the last 100 occurrences). Internal leaving chilled water reset control will ensure that the parallel evaporators are operated above the freeze point for part load operation.

DDC Controller shall have flashing Light Emitting Diode (LED) for the following: compressor 1 fault, compressor 2 fault, sensors for compressor 1 out of range, sensors for compressor 2 out of range, compressor alarm, motorized water valve alarm, hot water temperature alarm, cold water temperature alarm, load flow failure, source flow failure, and main power phase loss.

Bacview 6 with cable must be used for setting controller at start up. Bacview 6 can also be used to operate, monitor, and change default settings, or as a service tool for the unit.

Warranty:
ClimateMaster shall warranty equipment for a period of 12 months from start up or 18 months from shipping (whichever occurs first). Warranty is not activated until 1). water test is approved, and 2). factory start-up is complete.

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Strainers:
The following strainers will be shipped loose: for field installation.
a. 3" FPT Y-strainer. 60 mesh screen. Provide one at each water inlet.

Phase monitor: Provide phase monitor shipped loose.

(3) Tranquility® Console Model "TRC" Size 09-18 60 Hz

General:
Furnish and install ClimateMaster Tranquility® "Console" Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

All units shall be fully quality tested by factory run testing under normal operating conditions.

Basic Construction:
Console units shall have one of the following air flow and piping arrangements: Front Inlet/Right-hand Piping; Front Inlet/Left-hand piping; Bottom Inlet/Right-hand piping; or Bottom Inlet/Left-hand piping as shown on the plans. Engineer must approve any changes in layout.

The cabinet, wall mounted back wrapper and subbase shall be constructed of heavy gauge galvanized steel with a baked polyester powder coat paint finish. Corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. Unit corrosion protection must meet these stringent requirements or unit(s) will not be accepted. Color will be Polar Ice. Both sides of the steel shall be painted for added protection. Additionally, the wall mounted back wrapper shall have welded corner bracing. The easily removable cabinet enclosure allows for easy service to the chassis, piping compartment and control compartment.

All interior surfaces shall be lined with 1/4 inch (6.4mm) thick, 2 lb/ft3 (32 kg/m3) acoustic flexible

blanket type glass fiber insulation with a non-woven, anti-microbial treated mat face. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

The cabinet shall have a 30º sloped top with aluminum rigid bar type discharge grille. Aluminum discharge grille shall be anodized charcoal grey in color including hinged control door. Cabinet shall have rounded edges (0.325 inch / 8.255 mm minimum radius) on all exposed corners for safety and aesthetic purposes.

Return Air Filter shall be 1" (25.4mm) fiberglass disposable type media for bottom return units (units with sub-base) or 1/8" (3.2mm) permanent cleanable type media for front return type units.

The unit shall be provided with a keyed lock on the control access door.

Provide UltraQuiet package shall be provided and consist of high technology sound attenuating material that is strategically applied to the compressor and compressor compartment in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions. Compressor is mounted on specially engineered sound-tested EPDM isolators.

Fan and Motor Assembly:
Fan and motor assembly shall be assembled on a slide out fan deck with quick electrical disconnecting means to provide and facilitate easy field servicing. The fan motor shall be multi-speed, permanently lubricated, PSC type, with internal thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall include a torsionally flexible motor mounting system or saddle mount system with resilient rings to inhibit vibration induced high noise levels associated with "hard wire belly band" motor mounting. The airflow rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no filter shall NOT be acceptable.

Refrigerant Circuit:
All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the disconnect switch.

Hermetic compressors shall be internally sprung. The compressor will be mounted on specially engineered

sound-tested EPDM vibration isolation grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be "electro-coated" with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced type with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

The unit will be supplied with internally mounted secondary pump for primary/secondary applications, specifically one-pipe systems. (Requires extended unit). The pump shall be capable of 4.5 gpm at 35 ft. of head.

The unit shall be supplied with extended range insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Piping:
Water piping shall terminate in the same location regardless of the connection and valve options.

Provide threaded MPT copper fittings.

Drain Pan:
The drain pan shall be constructed of stainless steel. Drain pan shall be insulated. Drain outlet shall be located at pan as to allow complete and unobstructed drainage of condensate. The unit as standard will be supplied with solid-state electronic condensate overflow protection.

Electrical:
Unit control shall be located under the hinged control door in the sloped top grille. Operating control shall consist of push buttons to select mode of operation "OFF", "HEAT," "COOL," "AUTO", Fan "AUTO"

(fan cycles with compressor), Fan "ON" (continuous fan), Fan "LO" (low speed fan), and Fan "HI" (high speed fan). Temperature adjustment shall be accomplished via two push buttons, one labeled with an arrow up, and the other labeled with an arrow down. Control shall include an LCD display for display of temperature and setpoint.

A control box shall be located above the unit compressor compartment and shall contain operating controls as outlined in the paragraph above, 24VAC transformer, double-pole compressor relay, and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers.

Provide disconnect Switch, Non-Fused.

Option: Breaker.

Solid State Control System (CXM):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.
c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or anti-freeze).
p. Air coil low temperature sensing.

Provide enhanced solid state control system (DXM). This control system features two stage control of cooling and two stage control of heating modes for exacting temperature and dehumidification purposes.

This control system coupled with a multi-stage thermostat will better dehumidify room air by automatically running the heat pump's fan at lower speed on the first stage of cooling thereby implementing low sensible heat ratio cooling. On the need for higher cooling performance the system will activate the second stage of cooling and automatically switch the fan to the higher fan speed setting. This system may be further enhanced with a humidistat.

Control shall have all of the above-mentioned features of the CXM control system along with the following expanded features:

a. Removable thermostat connector.
b. Night setback control.
c. Random start on return from night setback.
d. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
e. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
f. Dry contact night setback output for digital night setback thermostats.
g. Ability to work with heat pump or heat/cool (Y, W) type thermostats.
h. Ability to work with heat pump thermostats using O or B reversing valve control.
i. Emergency shutdown contacts.
j. Boilerless system heat control at low loop water temperature.
k. Ability to allow up to 3 units to be controlled by one thermostat.
l. Relay to operate an external damper.
m. Ability to automatically change fan speed from multistage thermostat.
n. Relay to start system pump.
o. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

Digital Night Setback with Pump Restart (DXM w/ATP32U03/04)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM controller with an ATP32U03/04 thermostat and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period.

An additional accessory relay on the unit DXM controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel (CXM/DXM):
Solid state control system shall communicate with remote thermostat with fault indicator, to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat. Temperature controls contractor shall provide

field mounted controller.

Warranty:
Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Temperature and controls contractor shall provide thermostats.

Subbase Grille:
Decorative louvered grille covers the front of subbase including the large return air opening. Order separate and field attach.

(4) Tranquility® Model "Ts" Size 006-070 60hz

General:
Furnish and install ClimateMaster Tranquility® "TS" Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

All units shall pass a factory acceptance test.

Basic Construction:
Horizontal Units shall have one of the following air flow arrangements: Left Inlet/Straight (Right) Discharge; Right Inlet/Straight (Left) Discharge; Left Inlet/Back Discharge; or Right Inlet/Back Discharge as shown on the plans. Units must have the ability to be field convertible from straight to back or back to straight discharge with no additional parts or unit structure modification. Horizontal units will have factory installed hanger brackets with rubber isolation grommets packaged separately.

Vertical Units shall have one of the following air flow arrangements: Left Return/Top Discharge, Right Return/Top Discharge, Left Return/Bottom Discharge, Right Return/Bottom Discharge as shown on the plans.

All units (horizontal and vertical) must have a minimum of three access panels for serviceability of compressor compartment.

Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in

(12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) foil faced fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream.

The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection.

Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22.

All horizontal units to have factory installed 1" (25.4mm) discharge air duct collars. Vertical units to have field installed discharge air duct collar, shipped loose. If units with these factory-installed provisions are not used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions. All filter racks installed by mechanical controls are not integrated unit.

All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable. All filters will be installed in separate filter rack installed by return ductwork.

Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

UltraQuiet package (available on TS018-070 Units) shall be provided and consist of high technology sound attenuating material that is strategically applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions

The unit shall be supplied with extended range Insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Fan and Motor Assembly:
Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units shall have a direct-drive centrifugal fan. The fan motor shall be 3-speed, permanently lubricated, PSC type, with internal thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor on small and medium size units (006-012) shall be isolated from the fan housing by a torsionally flexible motor mounting system with rubber type grommets to inhibit vibration induced high noise levels associated with "hard wire belly band" motor mounting. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. Airflow / Static pressure rating of the unit shall be based on a wet coil and a

clean filter in place. Ratings shall NOT be acceptable based on a dry coil and/or no air filter.

Provide ECM motors (sizes 018 to 070): The fan motor shall be an ECM variable speed ball bearing type motor. The ECM fan motor shall provide soft starting, maintain constant CFM over its static operating range and provide airflow adjustment on its control board. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. A special dehumidification mode shall be provided to allow lower airflows in cooling for better dehumidification. The dehumidification mode shall be selectable via a dip switch on the control board or may be controlled externally from a humidistat.

Refrigerant Circuit:
All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency scroll or rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube or all aluminum micro channel refrigerant to air $_{heat}$ exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the unit manufacturer supplied disconnect switch.

Hermetic compressors shall be internally sprung. The compressor shall have a dual level vibration isolation system. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. All units (except units with rotary compressors) shall include a discharge muffler to further enhance sound attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube or all aluminum micro channel construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced types with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

Drain Pan:

The drain pan shall be constructed of 201LN Stainless Steel to inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow unobstructed drainage of condensate. Drain outlet for horizontal units shall be connected from pan directly to FPT fitting. No hidden internal tubing extensions from pan outlet extending to unit casing (that can create drainage problems) will be accepted. The unit as standard will be supplied with solid-state electronic condensate overflow protection.

Vertical units shall be furnished with a PVC FPT condensate drain connection and an internal factory installed condensate trap. If units without an internal trap are used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions.

Electrical:
A control box shall be located within the unit compressor compartment and shall contain a 50VA transformer, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor.

Units shall be supplied with factory installed non-fused electrical service disconnect switch.

Solid State Control System (CXM):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.
c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or antifreeze).
p. Air coil low temperature sensing.

Solid State ECM Fan Control Board (60 Hz Units with ECM Fan Option Only):
Airflow selection shall be accomplished via 3 jumper switches on the ECM control board. Actual airflow shall be indicated by the CFM LED with each 100 CFM being represented by one flash of the LED. Airflow shall be automatically maintained (±5%) by the ECM motor regardless of external static pressure up to its maximum output capacity. A jumper shall allow selection of a special dehumidification mode, which reduces airflow in cooling by 25% to increase the latent capacity of the unit. A terminal shall be provided on the control board to allow an external humidistat to activate dehumidification mode.

Provide enhanced solid state control system (DXM). This control system features two stage control of cooling and two stage control of heating modes for exacting temperature and dehumidification purposes.

This control system coupled with a multi-stage thermostat will better dehumidify room air by automatically running the heat pump's fan at lower speed on the first stage of cooling thereby implementing low sensible heat ratio cooling. On the need for higher cooling performance the system will activate the second stage of cooling and automatically switch the fan to the higher fan speed setting. This system may be further enhanced with a humidistat.

Control shall have all of the above mentioned features of the CXM control system along with the following expanded features:

a. Removable thermostat connector.
b. Night setback control.
c. Random start on return from night setback.
d. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
e. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
f. Dry contact night setback output for digital night setback thermostats.
g. Ability to work with heat pump or heat/cool (Y,W) type thermostats.
h. Ability to work with heat pump thermostats using O or B reversing valve control.
i. Emergency shutdown contacts.
j. Boilerless system heat control at low loop water temperature.
k. Ability to allow up to 3 units to be controlled by one thermostat.
l. Relay to operate an external damper.
m. Ability to automatically change fan speed from multistage thermostat.
n. Relay to start system pump.
o. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

Digital Night Setback with Pump Restart (DXM w/ ATP32U03/04)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM controller with an ATP32U03/04 thermostat and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period. An additional accessory relay on the unit DXM controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel (CXM/DXM):

Solid state control system shall communicate with thermostat to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat.

Temperature and controls contractor shall provide field mounted controller.

Warranty:
Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Thermostats shall be provided by temperature controls contractor. Refer to 235200.

(5) Tranquility® Model "TE" Size 026-072 60hz

General:
Furnish and install ClimateMaster Tranquility® "TE" Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped, and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

All units shall pass a factory acceptance test.

Basic Construction:

Vertical Units shall have one of the following air flow arrangements: Left Return/Top Discharge, Right Return/Top Discharge, Left Return/Bottom Discharge, Right Return/Bottom Discharge as shown on the plans.

If units with these arrangements are not used, the contractor is responsible for any extra costs incurred by other trades. All units (vertical) must have a minimum of three access panels for serviceability of compressor compartment.

Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) foil-faced fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Units without foil-faced insulation in the air handling section will not be accepted.

The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection.

Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22. Unit insulation must meet these stringent requirements or unit(s) will not be accepted.

Vertical units to have field installed discharge air duct collar, shipped loose. If units with these factory-installed provisions are not used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions. Filter racks shall be installed in return ductwork by mechanical contractor. Filter rails are not required by unit.

All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable.

Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor shall be responsible for any extra costs involved in the installation of units that do not have this feature. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

UltraQuiet package shall consist of high technology sound attenuating material that is strategically applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions.

The unit shall be supplied with extended range insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Fan and Motor Assembly:
Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units shall have a direct-drive centrifugal fan. The fan motor shall be an ECM variable speed ball bearing type motor. The ECM fan motor shall provide soft starting, maintain constant CFM over its static operating range and provide airflow adjustment in 25 CFM increments via its control board. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. A special dehumidification mode shall be provided to allow lower airflows in cooling for better dehumidification. The dehumidification mode may be constant or automatic (humidistat controlled). Airflow/Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil, and/or no air filter, shall NOT be acceptable.

Refrigerant Circuit:
All units shall contain an EarthPure®(HFC-410A) sealed refrigerant circuit including a high efficiency two-stage scroll compressor designed for heat pump operation, a thermostatic expansion valve for

refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube or all aluminum micro channel refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the unit manufacturer supplied disconnect switch.

Hermetic compressors shall be internally sprung. The compressor shall have a dual level vibration isolation system. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. All units shall include a discharge muffler to further enhance sound attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube or all aluminum microchannel construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced types with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

Drain Pan:
The drain pan shall be constructed of Stainless Steel to inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow unobstructed drainage of condensate. No hidden internal tubing extensions from pan outlet extending to unit casing (that can create drainage problems) will be accepted. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches will NOT be accepted.

Vertical units shall be furnished with a PVC FPT condensate drain connection and an internal factory installed condensate trap. If units without an internal trap are used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions.

Electrical:
A control box shall be located within the unit compressor compartment and shall contain a 75VA

transformer, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor.

Units shall be supplied with factory installed non-fused electrical service disconnect switch.

Solid State Control System (DXM2):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall have the following features:

- Anti-short cycle time delay on compressor operation.
- Random start on power up mode.
- Low voltage protection.
- High voltage protection.
- Unit shutdown on high or low refrigerant pressures (loss of charge).
- Unit shutdown on low water temperature.
- Condensate overflow electronic protection.
- Option to reset unit at thermostat or disconnect.
- Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
- Ability to defeat time delays for servicing.
- Light emitting diode (LED) on circuit board to indicate high pressure, low pressure (loss of charge), low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
- The low-pressure (loss of charge) switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
- 24V output to cycle a motorized water valve or other device with compressor contactor.
- Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
- Water coil low temperature sensing (selectable for water or antifreeze).
- Air coil low temperature sensing.
- Removable thermostat connector.
- Night setback control.
- Random start on return from night setback.
- Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
- Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
- Dry contact night setback output for digital night setback thermostats.
- Ability to work with heat pump (Y, O) or heat/cool (Y, W) type thermostats.
- Ability to work with heat pump thermostats using O or B reversing valve control.
- Emergency shutdown contacts.

- Boilerless system heat control at low loop water temperature.
- Ability to allow up to 3 units to be controlled by one thermostat.
- Relay to operate an external damper.
- Ability to automatically change fan speed from multistage thermostat.
- Relay to start system pump.
- 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

To achieve full benefit of the two-stage compressor and ECM fan, a 2 Heat/2 Cool thermostat should be employed. Thermostat shall be provided by temperature controls contractor.

Digital Night Setback with Pump Restart (with ATP32U03, ATP32U04, ATC32U02C)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM2 controller and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period.

An additional accessory relay on the unit DXM2 controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel:
Solid state control system shall communicate with thermostat to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat.

Temperature and controls contractor shall provide field mounted controller.

Warranty:
Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Temperature and controls contractor shall provide thermostats.

A. HOSE KITS

(1) HOSE KIT SIZES SHALL BE AS SCHEDULED ON THE DRAWINGS.

a. Provide a factory-assembled, one piece hose kit/piping package for supply and return connections for each heat pump.

b. Contractor shall provide and install Hays Hose Kit Piping Packages or Nexus Hose Kit Piping packages. Each kit shall be sized for 2.0 to 7.0 feet per second. Valves may be mounted in any altitude and do not require straight sections of pipe either upstream or down stream for proper operation. Griswold is not an acceptable manufacturer.

c. Each return side hose kit/piping package shall include the following:

1) Single piece Y - valve body for sizes ½" – 1-1/2", shall be constructed of hot forged brass with threaded inlets and outlets. 2" – 3" shall be constructed of bronze. 4" and larger shall be constructed of carbon steel with flanged inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure.

2) Single pressure/temperature test ports for verifying the pressure differential and system temperature, full flow design ball valve with blow out proof stems for shut off.

3) Manufacturer shall provide certified independent laboratory tests verifying accuracy of performance.

4) All valves shall be labeled with controlled flow direction, flow rate, PSID control range, manufacturer and model number, unit tagging.

5) Check valve.

d. Each supply side hose kit/piping package shall include the following:

1) Single piece Y - valve body for sizes ½" – 1-1/2", shall be constructed of hot forged brass with threaded inlets and outlets. 2-3" shall be constructed of bronze. 4" and larger shall be constructed of carbon steel with flanged inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure.

2) Single pressure/temperature test ports for verifying the pressure differential and system temperature, full flow design ball valve with blow out stems for shut off.

3) Strainer shall be Y-type configuration furnished with hose connector blow down valve. Strainer screen shall be stainless steel mesh and easily accessible for cleaning without disconnecting hoses.

4) All valves shall be labeled with flow direction, manufacturer and model number, unit tagging.

e. Stainless Steel Braided Supply and Return Hoses: All hoses shall be equipped with end connections at terminal unit. All end connections shall be either permanently crimped swivel ends or butt welded to carbon steel end fittings to meet stated pressure ratings. Operational temperature shall be rated from fluid freezing to 200 degrees F. Minimum burst pressure shall be four times the working pressure. Furnish with field flushing connection fitting. ½" to 1-1/4" shall be reinforced, fire retardant EPDM rubber, bonded to the inside wall of braiding. 1 ½" and larger shall be a corrugated type 321 stainless steel tube.

f. Flushing Bypass: Provide with means at each heat pump to flush system completely while allowing no fluid flow through heat pump. Also see "Start-up and Flushing" instructions in this section.

g. Condensate Hose Kits: Contractors Option: Manufactured ¾" tubing x 54" long clear flexible plastic hose, with molded P-trap, fittings, couplings and clamps. All condensate drains larger than ¾" shall be field fabricated by contractor to allow for flexible movement. All sizes shall match sizes indicated on drawings.

h. Warrantee: Manufacturer shall warrant all components, for no less than five (5) years from date of purchase. Manufacturer shall warrant steel braided hose for no less than three (3) years from date of substantial completion.

B. VENTILATING FANS

(1) Ventilating fans shall be of the type, capacity, size, etc. here-in-after scheduled. Catalog numbers are listed as design criteria only. Alternate selections will be accepted provided quality, function, etc. are equivalent. All fans shall be UL listed, complete with all required disconnects and starters and shall be AMCA rated and certified. Model numbers listed are Greenheck, acceptable alternates are Penn, Carnes, Acme, Shipman, Jenn-Aire, Loren-Cook, and Twin City. The Architect shall select the color for all exposed fans.

(2) Selection

Refer to the schedule on the plans.

C. DEDICATED OUTSIDE AIR UNIT OA-1

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Design, performance criteria, controls, and installation requirements for indoor mounted Custom Air Handling Units.

1.2 REFERENCES

A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings
B. AMCA Publication 99 – Standards Handbook
C. AMCA Standard 203 – Field Performance Measurement of Fan Systems
D. AMCA Standard 210 – Laboratory Methods of Testing Fans for Performance Rating
E. AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans
F. AMCA Standard 500 – Laboratory Methods for Testing of Dampers and Louvers
G. ARI Standard 410 – Forced Circulation Air-Cooling and Air-Heating Coils
H. ANSI/ASHRAE Standard 111 – Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
I. ASHRAE Standard 52.1 – Dust-Spot Procedures for Testing Air-Cleaning Devices
J. ANSI/ASHRAE Standard 52.2 – Method of Testing Air-Cleaning Devices for Removal Efficiency by Particle Size
K. ANSI/ASHRAE 15 – Safety Standard for Refrigeration Systems
L. ANSI/ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality

M. ANSI/ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential
N. ARI 1060 – Performance Rating of Air to Air Energy Recovery Ventilation Equipment
O. ASTM A-653 – Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process
P. ASTM B117 – Standard Practice for Operating Salt Spray Apparatus
Q. IBC 2006-2012 – International Building Code
R. NEMA MG1 – Motors and Generators
S. NFPA 70 – National Electric Code
T. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
U. UL 900 – Test Performance of Air Filters
V. UL 1995 – Standard for Heating and Cooling Equipment

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1
B. Submittals shall include the following:
   1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
   2. Cabinet material, metal thickness, finishes, insulation and accessories.
   3. Ladder-type schematic drawing of the power and auxiliary utility field hookup requirements, indicating all items that are furnished by the manufacturer.
   4. Manufacturer's performance of each unit. Selection shall indicate, as a minimum, the following:
      a. Fan curves with system operating conditions indicated.
      b. Certified coil performance ratings with system operating conditions.
      c. Calculations required for base rail heights to satisfy condensate trapping requirements of cooling coil.
      d. Filters with performance characteristics.
      e. Rated load amp draw.
      f. Approximate unit shipping weight.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALIFICATIONS

A. Manufacturer shall be a company specializing in the design and manufacture of air handling equipment and in business for no less than 15 years.
B. Each unit shall bear an ETL label, conforming to UL Standard 1995.
C. Units shall comply with the requirements of UL 1995 and NFPA 90.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the supervision of the owner in accordance with the manufacturers Operation and Maintenance Instructions.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

1.8 WARRANTY

A. The complete unit shall be covered by a parts only warranty issued by the manufacturer covering the first year of operation. The warranty period shall start on the date of equipment startup or six months after the date of shipment, whichever occurs first.

B. The installing contractor shall provide labor warranty during the unit's first year of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

1) Basis of design is ClimateCraft. To be approved, manufacturers shall meet or exceed performance and construction aspects as described and detailed herein. Submittal is to be in sufficient detail to determine equivalency.

2.2 GENERAL

A. Units shall be completely factory assembled and tested with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. 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 to indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and Maintenance manuals shall be furnished with each unit.

2.3 CABINET CONSTRUCTION

A. Cabinets shall be constructed in a watertight and airtight manner. The manufacturer's standard cabinet construction shall result in an ASHRAE/ANSI Standard 111 Leakage Class 5 rating, or better, as measured in accordance with AMCA Standard 210. A leakage rate as a percent of airflow shall only be submitted following calculation at specific project conditions. Maximum casing leakage (cfm/100 ft^2 of casing surface area) = CL X $P^{0.65.}$ Published leakage rates at generic conditions shall not be submitted.

B. Casing deflection shall not exceed L/200 at +10.0 w.g. in all positive pressure sections and -10.0 w.g. in all negative pressure sections where L is defined as the panel span. Panels shall be designed to deflect no more than 1/200 (.0005" per inch) of span under operating design conditions when measured at the panel span. Casing shall be rated for 1.0% leakage at 1.5 times the operating pressure with a maximum overall pressure of 10" w.g.

C. The unit shall be constructed on a 5"welded structural tubular steel base. Base tubing shall be cold-formed carbon steel, electric resistance welded. Formed intermediate cross members shall be constructed of hot rolled 12-gauge galvanized steel. After fabrication, the base frame shall be thoroughly cleaned and coated with high solids, polyamide epoxy paint system for superior corrosion resistance.

D. Units shipped in multiple sections shall be engineered for ease of field assembly. Gasket supplied with the unit shall be a high quality weather resistant closed-cell EPDM sponge rubber. Each section shall include a permanent label to aid in proper field assembly. All gasket and necessary assembly hardware shall ship loose with unit. Floors shall be designed to deflect no more than 1/200 of span under operating conditions.

E. Floors
   a. Shall be fabricated of 16-gauge G-90 galvanized steel. All floor sheets shall be isolated from the base assembly with an EPDM thermal break gasket.
   b. Floors shall be insulated with a two-part polyurethane water impervious foam insulation. If glass fiber insulation is used, a 20-gauge type 304 stainless steel under liner shall be provided.
   c. Under liner shall also be provided when bottom of unit is used as an air tunnel. Under liner shall be fabricated of 16-gauge G-90 galvanized steel

F. Wall and roof panels
   a. Panels shall be 2" thick double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal. Air handling manufacturers using caulk to seal panels must include an owner witnessed field leakage test. The test shall require the unit to be field design air flow tested and cabinet leak tested for 1.0% at 1.5 times the operating pressure.
   b. Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 5/16" bolts that can be removed and refastened. Panel attachment with screws is not acceptable. All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.
   c. For long term durability, exterior panels shall be a minimum 16-gauge G60 galvanized steel pre-painted with a baked on polyester-ceramic paint system that passes a 1,000 hour ASTM B-117 salt spray resistance test and 3000 hour ASTM G-23 accelerated weathering test.
   d. Interior liners shall be a minimum 20-gauge G90 galvanized steel. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

G. Insulation
   a. All wall and roof panels shall be insulated with an injected foam insulation with an R value of 6.6 per inch. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel seam. Insulation shall fill the panel without voids. Panels shall have a minimum 20-gauge G90 galvanized steel solid interior liner.

H. Access doors shall be provided into all sections of the air-handling unit as indicated in the plan documents. Doors shall be sized as shown on plan drawings, shall be a minimum 2" thick with R13 polyurethane foam insulation and shall be double wall construction using the same material type as the corresponding section. Doors shall comply with the requirements of UL 1995 and NFPA 90. The door frame shall be 0.125" extruded 6063-T5 aluminum. Each door shall be mounted with adjustable die cast aluminum hinges. All doors and mounting frames shall incorporate a thermal break design and the doors shall seal to a replaceable extruded EPDM sponge rubber gasket. Doors shall open against static pressure or shall include a pressure relief feature on the door latch.
   a. The door latch assembly shall consist of a roller cam compression arm with a chrome plated steel inner handle and glass fiber/nylon composite outer handle. One {tool operated} lock shall be provided on each fan section access door. All doors shall have a minimum of two latches.
   b. A 10"x12" thermal pane viewing window with one wire mesh safety glass pane and one clear pane shall be provided. The frame shall have a no-through-metal thermal break design. Viewing windows shall be on all doors serving fan array motors. Windows on doors exposed to unit mounted UVC light shall use glass that is resistant to UVC transmission.

I. The entire unit, including walls, roof, doors, joints, and seams shall include thermal break construction. This construction shall be supported by tested performance producing no condensation on the exterior surface when the air tunnel temperature is 50°F DB under the following exterior conditions:

i. $(Th - 50) / (Th - Tdp) < 3.4$

b. Th = Ambient dry bulb temperature (°F) external to housing

c. Tdp = Ambient dew point temperature (°F) external to housing

2.4 FAN ASSEMBLIES – DIRECT DRIVE FAN ARRAY

1) Approved manufacturers: ClimateCraft, Daikin, and Trane

a) Fan Arrays shall be direct-drive, non-overloading SWSI plenum fans designed for industrial duty and suitable for continuous operation.

i) Fans shall be arranged in an array using one or more welded structural steel assemblies and shall be of the size and quantity specified in the unit schedule. Screwed or riveted frames are unacceptable. Fan assemblies shall be attached directly to base structural members.

ii) Fan wheels shall have a minimum of 12 airfoil blades for superior sound characteristics and shall be constructed of aluminum to reduce rotational weight and vibration. Fan blades shall be extruded aluminum for uniformity and improved vibration characteristics.

iii) Each fan and motor assembly shall be independently isolated within the structural assembly using 1-inch deflection spring isolators. Isolators shall be mounted in a three-point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. If hard mounted or rubber in shear is used in place of internal spring isolations, external isolation of the entire unit is required. Isolation system shall be seismic rated.

iv) A fan inertia base shall be provided or the fan structure shall exceed an equivalence of 2x mass of the total rotating parts of the fan array. Fan and motor assemblies shall be designed such that no natural frequencies exist within the operating RPM range of the fan, eliminating the need for "lockout" frequency settings in the variable speed drive. The purchasing contractor will be responsible for all costs associated with externally isolating any unit that does not include individual fan isolation.

v) All fan arrays shall meet the minimum motor efficiency, maximum brake horsepower and total motor horsepower values scheduled. 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. Manufacturer must ensure maximum fan RPM is below the first critical speed. Fans shall be Class 3 construction.

vi) All fan and motor assemblies shall be dynamically balanced by the manufacturer to a maximum allowable vibration of 0.040 inches per second at design RPM and a maximum 0.080 inches per second overall vibration limit to bring the fan balance in conformance to a BV-5 Grade G1 per ANSI/AMCA 204. In addition, the manufacturer shall insure that no critical frequencies exist in the fan operating range by varying motor speed in 1Hz increments from design RPM to 50% of design RPM.

b) Unloading / Turndown

i) Acceptable technologies: BalanceStream™, FanWall® System Optimization, Econo-disk® or Vari-cone®

ii) The supply fan array shall be provided with unloading technology to allow fan modulation without surge from 100% to 10%; while maintaining a duct static pressure control set

point of 1.00" w.g. There shall be no static pressure or intake plenum losses or any horsepower penalty associated with the system.

iii) BalanceStream is a self-contained system independent of the building system temperature controls. No powered actuators or control signals are required. Any control points required to operate the unloading sequence shall be wired by the AHU manufacturer to a single point of control for the building automation system to interface. If control points are required, coordination with the BASD manufacturer on control sequence responsibilities shall be required at time of submittal approval.

iv) The system shall provide a positive shutoff for each fan in case of a fan failure. Each fan shall be provided with an isolation or backdraft damper to prevent bypass in the event of a motor failure. Blank off plates requiring manual installation are not acceptable.

v) Fan cycling to allow stable part load operation shall be allowed only if a maximum of 50% of the fans will be cycled off at any time. Each fan is to be cycled in such a manner that all fans operate an equal number of hours in any given 168-hour (1-week) operating period. Control system shall indicate the individual fans operating and not operating. A separate control signal shall be required to indicate fan failure, separate from an indication that a fan is intentionally controlled to be off.

vi) Fan curves shall be submitted; with the system curve indicating the minimum system operating static pressure and the point of fan surge.

c) Motors

i) Electrical characteristics and horsepower shall be as specified on the project schedule.

ii) Motors shall be Premium Efficiency per NEMA MG1 Table 12-12 ODP type, shall have NEMA Class F insulation, shall meet NEMA Standard MD-1 Inverter Duty rating and shall be designed to withstand 1600V peak voltage spikes and rise times ≥0.1 microseconds.

iii) Motors shall have grease lubricated ball bearings designed to deliver a minimum L10 life of 250,000 hours at full load and the maximum operating RPM of the associated fan. Grease zerks and spring loaded grease relief valves shall be provided in each motor to allow easy bearing lubrication without damaging the seals due to over lubrication. Permanently lubricated bearings are allowed if a spare motor per array is provided.

iv) For efficient operation in a direct drive application, motors shall be capable of operating greater than 60HZ to at least the design operating speed of the fan.

v) Motors shall be factory wired to a motor control center for connection to a VFD. The motor control center shall include for each motor circuit a control device providing overload protection, short circuit protection and a manual disconnect means, and all circuits shall be wired to a common main panel terminal block. Each control device shall include an auxiliary output capable of providing remote notification of a motor failure. All motors shall operate at all times and be controlled in unison, maintaining a consistent and uniform airflow pattern over coils, filters and other devices.

vi) Each motor shall be provided with a shaft grounding device to harmlessly bleed potential induced shaft voltages to ground.

d) Warranty

i) All rotating parts shall be warranted by the unit manufacturer for a full five (5) years from date of unit start-up. Parts warranties provided by third parties are not acceptable.

e) Provide the following options

i) Fans shall be provided with outlet guards to protect service personnel.

ii) Each array shall be provided with one inlet airflow blank-off plate to be used in case of a motor failure. Plate to include handles and latches for quick installation.

2) Fan Array Controls

A. Fan arrays shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

B. Each fan array in the air handling unit shall be provided with a factory installed airflow measuring instrument. Every fan in the array will have an airflow measuring device that is guaranteed by the unit manufacturer to have no impact on the fan airflow performance and will not increase the fan sound power. The output of the airflow measurement device on each fan shall be wired by the unit manufacturer back to a central processor mounted on the cabinet exterior that will add the flow from each fan to provide a total airflow for the fan array. Using one air flow measuring device and multiplying by the number of fans provided is not acceptable due to lack of accuracy.
The central processor shall be able to detect and report a fan failure. Auxiliary contacts on the motors starters are not acceptable as fans can fail without tripping overloads. Current sensors wired into the central processors can be utilized. Acceptable manufactures are: AccAMP series ACSX, CR Magnetics model CR439, Greenheck FMS, NK Technologies series AS1.

Piezometric volume taps with pressure transducers are acceptable. Transducer accuracy shall be 1% of pressure reading from full scale down to 10% of full scale reading to improve accuracy to less than 0.5% of calculated flow from 100%-30% of flow. The square root linearization and conversion of the pressure signal to flow shall be done at the central processor. Acceptable pressure transducers are: MatrixMonitor™ Fan Sensor, Omega PX656, Greenheck FMS, Setra Model 239.

C. Measure the airflow back flowing through all failed fans in the array. The backflow shall be subtracted from the sum of the operating fans to provide an accurate delivered airflow for the entire fan array. The system measurement accuracy shall be $\pm$5% of measurement throughout the entire operating range of the fan array down to 15% of design flow. Systems with accuracy rated as a percentage of full scale are not acceptable. The system shall adjust for changes in barometric pressure and temperature to maintain accuracy in changing atmospheric conditions and at any altitude. The system shall be able to measure airflow and report it in units of ACFM or SCFM as selected by the user.
The system shall have the capability to communicate to the BMS with discretely wired analog signals or through an RS485 two wire multi drop network using the MODBUS protocol. All information available through the local keypad display unit shall be made available through the MODBUS or BACnet interface. At a minimum there shall be two locally scalable 0 to 10 VDC signals to report airflow and array pressure rise to the BMS. In addition, there shall be three SPDT relay outputs to report on the condition of the fan array. One relay will switch when the control is energized, one will switch in the event of fan failure detection and one will switch if fan surge is detected.

D. In addition to fan failure detection the system shall also be able to detect and report when any fan is in surge. The system shall have self-diagnostic capabilities and be able to report measurement and system errors. Individual and total flow measurements, entering air temperature and fan array pressure rise shall be available at a unit mounted key pad display.

E. Unit manufacturer shall supply and mount for each fan in the air handler a tri-axial accelerometer used to measure fan vibration. The output of each accelerometer shall be processed in real time through a FFT processor to provide frequency domain vibration for each fan. The vibration readings shall be reported in velocity and available for a frequency range that is a minimum of 3 times the operational speed of the fans. The system shall be capable of checking the fan vibration against user selectable vibration limits and reporting

when those limits are exceeded. Each fan vibration sensor will be tied back to the airflow monitor where the individual fan vibration levels can be displayed on the local keypad display and the alarms and data can be transmitted to the BMS through the MODBUS communication link. Acceptable manufacturers are: MatrixMonitor™ Fan Sensor, IMI Sensors model 685B, Greenheck FMS, Metrix Instrument Co. model 440.

F. Each fan array in the air handler shall be equipped with a grease monitoring system to track the intervals between motor bearing greasing. The system shall monitor the motor shaft speed for every fan motor in the array and integrate this data over time to determine the optimum elapsed time between bearing greasing. The system shall maximize the time interval between motor bearing greases while maintain proper lubrication of the bearings to maximize the motor life. The system shall notify the operator when it is time to grease the motor bearings through a locally mounted key pad display. The system will also estimate the number of days remaining until the motor bearings need to be greased. The system shall be capable of reporting the grease life information to the BMS through an RS485 two wire multi drop network using the MODBUS or BACnet communication protocol

2.5 FAN SPEED CONTROL

A. Each variable air volume supply and exhaust fan array shall be provided with an individual variable frequency drive. Drives shall be factory mounted and wired to the motor with adequate ventilation provided. The VFD shall be self-contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0 and 40-degree C. The VFD shall be 95% efficient at 100% rated output power, 60 Hz. The VFD shall be UL listed. Drives shall be mounted on the exterior of the unit housing or in a flush mounted, ventilated panel.

2.6 UNIT SOUND POWER

A. Fan sound power levels (dB) for the unit shall not exceed values as specified on the equipment schedule.

B. Unit manufacturer shall provide certified inlet, supply and casing radiated, sound power levels based on the final unit configuration.

2.7 COILS

A. Provide complete coil section(s) with service access door(s) as shown on the plan drawings. Coil connections shall extend through the section casing for ease of installation. Coil connections must be sealed from both the inside and exterior surfaces of the panel with the sleeve of the inner seal covering the pipe within the depth of the panel, all to minimize leakage and condensation. An integral double wall, stainless steel air seal which completely seals around the coil casing and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches.

B. Multiple, “stacked” coil arrangements must be constructed so as to allow independent removal of any coil without the removal of another within the coil bank.

C. All coils shall meet or exceed the capacities specified on the mechanical schedule and all water coil performances shall be certified in accordance with the AHRI Forced Circulation Air Heating and Air Cooling Coil certification program which is based on AHRI Standard 410. Face velocities shall not exceed those specified on the mechanical schedule.

D. All cooling coil sections shall include a double sloped drain pan constructed from 304L stainless steel. All corners shall be welded watertight. Coils shall rest on stainless steel supports. The pan

shall have a minimum pitch of 2" from high point to the bottom of the drain outlet connection, providing at least a 1/8" per foot slope. The drain pan shall be insulated with a 2-part sprayed on polyurethane, water impervious foam. Insulation shall be applied to the entire under side of the drain pan and coil section base assembly. If multiple stacked coils are used, intermediate drain pans are required. Intermediate pans shall be insulated and drained with 3/4" copper down-comers to the main pan.

E. Water coils shall be of a staggered tube design with high efficiency die formed corrugated plate-type fins for maximum performance. All coils shall be tested with 400 psig compressed air under clear water. Coils shall be designed to operate at 300 psig internal pressure and up to 250ºF. Tubes shall be 5/8" diameter, seamless 0.020" wall copper, mechanically expanded into full drawn fin collars for a continuous compression bond over the full finned length for high efficiency performance. Coil casings shall be a minimum 16-gauge stainless steel. Coil casing reinforcements shall be required for fin lengths over 42". Coil fins shall be 0.0075" thick aluminum. Coils shall be serviceable using 0.25" M.P.T. drain and vent taps on the supply and return headers. Threaded seamless red brass coil connections shall be brazed to copper supply and return headers.

2.8 FILTERS

A. Provide complete filter section(s) with filter racks and service access door(s) as shown on the plan drawings. Holding frames provided for medium efficiency applications will be either upstream or downstream accessible. Holding frames provided for high efficiency applications will be upstream accessible, only. Holding frames shall be constructed from heavy gauge galvanized steel and shall be equipped with polyurethane foam gaskets. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches. Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The holding frame shall be designed to accommodate standard size filters with the application of the appropriate type fastener. The filter rack shall be designed to use standard 24"x24" and 12"x24" filters only. Odd sized filters are not allowed. Holding frame assemblies shall be sized to meet or exceed the face area specified by the mechanical schedule.

B. Angle filter racks shall be provided where indicated. Angle racks shall be fabricated from a minimum 16-gauge steel. Angle racks shall be applied in medium efficiency filter applications, and will be either upstream or side accessible. Upstream access filter racks shall have one central access cover per row of filters, centered in the unit for easy access. Side access filter racks over 72" long shall include an angle center reinforcement support. Filter racks shall be sized to meet or exceed the area specified in the mechanical schedule. The filter rack shall be designed to use standard 24"x20" and 12"x20" filters only. Odd sized filters are not allowed.

C. A Magnehelic differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter bank. The gauge shall be a diaphragm-actuated dial type, 4¾" O.D., with white dial, black figures and graduations and pointer zero adjustment.

D. Medium efficiency pleated filters shall be 2" thick, 30% efficient MERV 13 as rated by ASHRAE Standard 52.1 test methods. Filter media shall be of the non-woven cotton fabric type. The filter shall have an average efficiency of 25-30%. Filters shall be UL900 Class 2 listed

2.9 DAMPERS

A. Outdoor air, exhaust air, bypass air, and coil face and bypass dampers shall be airfoil low-leak dampers, Damper shall be opposed blade type. The frame shall be fabricated from 16-gauge galvanized steel. Damper shall meet the leakage requirements of ASHRAE Std. 90.1 and of the International Energy Conservation Code by leaking less than 3 CFM/sq. ft. at 1" of static pressure, and shall be AMCA licensed as a Class 1A damper.

2.10 ENERGY RECOVERY

A. Wheel Media: The enthalpy wheel shall be constructed of corrugated synthetic fibrous media with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated, bonded, or synthesized onto the media are not acceptable due to possible delamination or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized (+/- 0.032 in) in order to minimize wear on inner seal surfaces and to minimize cross-leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for air flow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by air flow are unacceptable due to the possibility of channeling and performance degradation. Wheel media must be tested and recognized by UL or equivalent. The minimum acceptable performance shall be as specified in the drawings/submittal. Media shall be cleanable with low temperature steam, hot water or light detergent without degradation of latent performance. The ECW or enthalpy wheel shall be AHRI certified in accordance with Standard 1060 and carry the AHRI mark.

B. Desiccant Material: The desiccant material shall be molecular sieve with maximum internal pore diameter of four angstroms ("4A") or smaller to minimize cross contamination and provide maximum selectivity for the water vapor molecule.

C. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment.

D. Wheel Seals: The wheel seals shall be contact brush style on both the perimeter and face to provide for maximum resistance to leakage. Seals must be easily adjustable.

E. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box-tubing depending on size and weight of the enthalpy wheel. Cassettes shall have a built in adjustable purge section to minimize cross contamination. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, externally mounted flange bearings or pillow block style depending on cassette size. Drive system shall consist of an AC drive motor and multilink belt.

2.11 ELECTRICAL POWER AND CONTROLS

A. Unit operating voltage shall be 460V, 3 phase, 60Hz. All wiring and electrical equipment supplied by the manufacturer shall conform to and be installed in accordance with the requirements of UL1995.

Provide copper wires, bus bars, and fittings throughout, except internal wire of the control transformer may be aluminum if copper termination is provided. Identify power supply terminals with permanent markers. The maximum temperature of terminals shall not exceed 167°F (75°C) when the equipment is tested in accordance with its rating. Wiring shall be run in plated flexible metal conduit.

Mount a permanent nameplate on the unit to display the manufacturer, serial number and model number, date of manufacture, horsepower, current rating and voltage.

B. Furnish and install a NEMA 1 non-fused disconnect switch for the supply fan array and the exhaust fan array. Disconnect switches to be mounted on the exterior of the unit housing or in a flush mounted, ventilated panel.

C. Each section provided with a service access door shall be equipped with a vapor proof mini-fluorescent service light. All lights shall be completely installed and wired to a single switch. All switches shall be wired to the unit control panel. All switch boxes shall include a GFCI convenience receptacle. Lights shall be wired so they are functional whether the main power disconnect is in the on or off position.

2.19 UNIT TESTING AND QUALITY CONTROL

A. The fans shall be factory run tested to insure design integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. All direct drive fans shall be dynamically balanced as a complete assembly. Maximum vibration level shall be 0.080 inches/second peak velocity, filter-in readings taken with the filter tuned to the RPM of the fan. Units shall pass all quality control checks and be thoroughly cleaned prior to shipment.

B. The unit cabinet shall be tested to verify its cabinet leakage rating at design both positive and negative operating static pressure(s). Cabinet leakage shall not exceed a Leakage Class rating of 5 as defined by ANSI/ASHRAE Standard 111. Leak testing shall be performed by measuring the airflow pumped into (out of) the air-handling unit at the cabinet design operating static pressure. All unit openings shall be sealed. The air shall then be pumped into or out of the unit until the appropriate operating pressures are achieved. The testing shall be performed at the factory. A detailed report, including all data and test methods, shall be presented to the owner or his representative prior to equipment shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in strict accordance with manufacturer's requirements, shop drawings, and Contract Documents.

B. Equipment rigging and assembly to be supervised by a manufacturer certified service organization. Provide for as long a period of time as is necessary to ensure proper assembly or onsite training but no less than 2 full days.

C. Adjust in alignment on concrete foundations, sole plates or other supporting structure. Level, grout, and bolt in place.

D. Coordinate electrical installation with electrical contractor.

E. Coordinate controls with control contractor.

F. Provide all appurtenances required ensuring a fully operational and functional system.

3.2 START-UP

A. Equipment start-up is to be supervised by the unit manufacturer or a manufacturer-certified service organization. Physical connections and start-up are provided by the installing contractor. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and

manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.

B. Provide complete Operation & Maintenance Manuals with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

D. HEAT PUMP DOMESTIC WATER HEATER DWHP-1

GENERAL

The heat pump water heater shall be packaged water source equipment, factory assembled and charged. The heat pump shall be suitable for heating potable water and have the capability of producing no less than 160°F (71°C) water, with heating capacity and C.O.P. as indicated on the application specific documents.

1. HEAT PUMP UNIT: Heat Pump unit shall consist of compressor, condenser, evaporator, hot water circulating pump, piping, and controls, factory piped and charged. The heat pump shall contain the following components, and features:

Evaporator: Shall be single-wall brazed plate type constructed with stainless steel plates.

Refrigerant: Refrigerant shall be R-134a.

Expansion Valve: Valves shall be specifically designed for heat pump use with field adjustable superheat feature. Expansion valve shall have MOP (Maximum Operating Pressure) type power element to effectively limit saturated suction temperature to 65°F (18°C).

Compressor: Hermetic scroll type by Copeland Corp., suitable for high temperature operation with R-134a refrigerant.

Compressor Controls: Compressor controls/accessories must include the following:

- Suction and Discharge Service Valves
- High and Low Refrigerant Pressure Safety Switches
- Indicator Lights for:
  - Power On
  - Hot Water Demand
  - High Pressure Fail
  - Low Pressure Fail
- Multi-function Phase Failure Relay
- Crankcase Heater and Relay

Provide BAS interface for integration into building controls.

Condenser: Stainless steel brazed plate vented double wall type. Single wall condenser construction shall not be allowed. UL Listed and suitable for high temperature operation with potable water.

Refrigerant Accessories:

A. Filter-driers: Non-Replaceable Core Type
B. Sight Glass: Moisture Indicating Type

Anti-Short Cycle Control: Units shall be factory wired to allow a maximum of twelve compressor starts per hour to prevent compressor short cycling and allow time for suction and discharge pressures to equalize permitting the compressor to start in an unloaded condition.

Hot Water Circulating Pumps: Shall be factory installed in-line all bronze or stainless steel body centrifugal type able to deliver rated flow against the external head shown on the drawings.

Source Water Circulating Pumps: Provided by others. Shall have capacity and construction as shown on the drawings. To be approved by the Engineer and the heat pump Manufacturer prior to installation.

Controls: The heat pump unit shall be factory wired for fully automatic operation. Safeties shall include compressor motor thermal overload protection, manual reset pressure stats, anti-cycling compressor relays, plus standard items recommended by the equipment manufacturer.

Constant Leaving Water Temperature Control. Heat pump shall be factory equipped with electronic temperature control valve
(e-TCV) which automatically maintains constant leaving water temperature regardless of entering water temperature. Leaving water temperature is set by the heat pump operator/user via a field adjustable electronic temperature controller.

Manufacturer: Colmac Industries, Inc.
Model: HPW-11

E. HYDRONIC SPECIALTIES

(1) Manufacturers

Subject to compliance with the specified and scheduled requirements the following manufacturers will be considered, but not limited to:

Hoffman
Amtrol/Thrush
Armstrong/Aurora
Bell & Gossett
Patterson
Taco
Victaulic
Wheatley

(2) Hydraulic Separator PSH-1/Air Release Vessel

The hydraulic separator shall be designed and constructed per ASME Code Section VIII Div. 1. Provide Taco 5900 Plus Flex Balance Series Air Separator.

(3) Expansion Tank

The tank shall be constructed in accordance with the ASME Code for unfired pressure vessels and shall be suitable for 125 PSI water working pressure and 340ºF maximum water temperature. The tank shall be a pre-charged, heavy duty butyl rubber diaphragm-type pressure vessel complete with standard tire charging valve. Refer to the plans for mounting orientation. Capacities shall be as scheduled on the drawings.

(4) Suction Diffusers

Provide at the inlet of each base mounted pump, a suction diffuser as manufactured by Bell and Gossett, Victaulic, Thrush, or approved equivalent. Each suction diffuser shall be equipped with a disposable fine mesh start-up strainer and an adjustable support foot to carry weight of inlet piping. Victaulic Series 731 G, W731G, Bell and Gossett Suction Diffuser, or equal.

(5) Flexible Connections

Provide at the inlet and discharge side of each base mounted pump, at each connection to major equipment requiring vibration isolation and where shown on plans, a flexible connector, Metraflex Metrasphere or Engineer approved equal. Flexible connectors shall be of the flexible neoprene and nylon or EPDM and suitable for 225 PSI working pressure and 230°F temperature. Couplings shall be installed per the manufacturer's recommendations, in close proximity to the source of the vibration.

Alternatively, in lieu of a flexible connector, three (3) Victaulic Style 77 flexible couplings may be used on suction side and discharge side of base mounted pumps (six Victaulic flexible couplings per pump).

(6) Pressure Reducing Valve

Provide at the point of connection of the domestic water line to the hydronic system and where shown on the plans, a pressure reducing valve by Thrush, Bell and Gossett, or Engineer approved equivalent. Such pressure reducing shall be provided with an inlet strainer and shall be set to maintain a pressure of 4 PSI in excess of that at the highest point in the hydronic system. Each pressure reducing valves shall be line sized.

(7) Manual Air Vents

Provide, where shown on the plans, at each rise in piping and where required a manual air vent.

(8) Automatic Air Vents

Provide, where shown on the plans, automatic air vents.

Alternatively, in water piping systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and as required for the elimination of expansion loops. (In accordance with Victaulic recommendations and as approved by the Engineer). Where expansion loops are required in Victaulic piping systems, use Victaulic flexible couplings on the loop(s).

2. FACTORY START-UP REPORTS

A. Provide factory start-up on site by a factory representative (not a third party contractor) for all HVAC equipment, including pumps, VFD's, heat pumps, etc. Submit factory start-up reports to the Engineer. The Mechanical Contractor and the Controls Contractor shall have a representative on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action taken shall be submitted to Engineer.

B. At a minimum, the report submitted to the Engineer shall include the following data:

(1) Water Source Heat Pumps

a. High voltage power supply is correct and accordance with the unit nameplate.
b. The phasing of the unit is correct per the compressor rotation.
c. The field wiring and circuit protection is the correct size.
d. The low voltage control circuit wiring is correct per the unit wiring diagram.
e. The piping system is clean and complete.
f. Verify water flow is established and circulating through all units.
g. The condensate line is properly sized, run, trapped and pitched.
h. The indoor blower turns freely without rubbing.

Start-up checklist and log: Upon unit start-up, the following items shall be checked and logged for each water source heat pump. Note, the items listed below must be verified/checked before the system is put into full operation:

i. Entering fluid temperature (heat and cool mode)
j. Leaving fluid temperature (heat and cool mode)
k. Temperature differential (heat and cool mode)
l. Return air temperature (heat and cool mode)
m. Supply air temperature (heat and cool mode)
n. Water coil heat exchanger (water pressure "in" – psig) (heat and cool mode)
o. Water coil heat exchanger (water pressure "out" – psig) (heat and cool mode)
p. Pressure differential (psig) (heat and cool mode)
q. Compressor amps
r. Compressor volts
s. Compressor discharge line temperature (after 10 minutes)
t. Refrigerant charge (oz.)
u. Test drain pan operation
v. Check and note strainer condition.
w. Check and note filter condition.

(2) Outside Air Units/Energy Recovery Units

a. Fan rotation
b. Recovery wheel rotation
c. Confirm all wiring connections are correct
d. Confirm all field wiring is correct

e. Adjust belt tensions and alignments
f. Confirm pipe connections are correct
g. Confirm sequence of operation is correct
h. Confirm damper operation

(3) Water-to-Water Heat Pumps

a. High voltage power supply is correct and accordance with the unit nameplate.
b. The phasing of the unit is correct per the compressor rotation.
c. The field wiring and circuit protection is the correct size.
d. The low voltage control circuit wiring is correct per the unit wiring diagram.
e. The piping system is clean and complete.
f. Verify water flow is established and circulating through all units.

Start-up checklist and log: Upon unit start-up, the following items shall be checked and logged for each water source heat pump. Note: The items listed below must be verified/checked before the system is put into full operation.

g. Source entering fluid temperature (heat and cool mode)
h. Source leaving fluid temperature (heat and cool mode)
i. Load entering fluid temperature (heat and cool mode)
j. Load leaving fluid temperature (heat and cool mode)
k. Temperature differential (heat and cool mode)
l. Water coil heat exchanger (water pressure “in” –psig) (heat and cool mode)
m. Water coil heat exchanger (water pressure “out” – psig) (heat and cool mode)
n. Pressure differential (psig) (heat and cool mode)
o. Compressor amps
p. Compressor volts
q. Compressor discharge line temperature (after 10 minutes)
r. Refrigerant charge (oz.)
s. Check and note strainer condition.

3. WATER TREATMENT

A. SCOPE

Provide a one-year water treatment program for the DTS/DTR; HPS/HPR, GS/GP water loop systems. The one-year period shall start from the date of substantial completion. The program shall minimize corrosion, scaling, and prevent biological fouling of the piping system.

B. QUALIFICATIONS

Chemicals, service, and equipment shall be supplied by a single water treatment company for undivided responsibility. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of commercial/industrial water treatment for at least 5 years, whose major business is in the field of industrial water treatment. The water treatment company shall have regional water analysis laboratories, service department, and full time representatives located within the trading area of the job site or facility.

Water treatment company shall be Bluegrass Kesco, Nalco, American Water Treatment.

C. SERVICE

Provide quarterly field service and Owner consultation. System water or fluid shall be tested for proper chemical parameters, clarity, and biological activity. If needed, provide chemical addition. Provide any laboratory and technical assistance required to achieve a successful program.

D. CHEMICALS

Provide one year's supply of the recommended chemical for scale and corrosion protection of the closed loop recirculating system. If needed, provide separate chemical to control microbiological growth in the system. Formulations shall not contain any ingredients which are harmful to system materials of construction.

E. EQUIPMENT

(1) Bypass Feeder

Provide one 5 gallon bypass chemical feeder for each system (DTS/DTR) and (GS/GR, HPS/HPR). Neptune DBF-5HP or approved equivalent.

(2) (DTS/DTR) and (GS/GR, HPS/HPR) Loop Filter.

Harmsco HIF or WB series fluid filter. Refer to schedule on the drawings for selection. Provide with a total of three sets of filter cartridges.

F. REPORTS

A summary of water or fluid quality and treatment shall be provided in writing to the Owner and Engineer after each quarterly site visit. Results of quarterly biological activity tests shall also be provided to the Owner and Engineer.

4. GEOTHERMAL AND HEAT PUMP SYSTEM CLEANING

A. GENERAL

The heating/cooling system for this contract is a hydronic heat pump system and there are several precautions which must be observed during its installation. The Contractor is advised to read all of the manufacturer's instructions prior to commencing the installation.

B. SYSTEM START-UP

The Contractor shall include as a part of his work a factory system fill and start-up by an authorized Factory Representative of the unit manufacturer.

C. CLEANING AND FLUSHING HYDRONIC HEAT PUMP PIPING SYSTEMS

(1) During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.

(2) After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil and any and all other material foreign to the water.

(3) Before chemical cleaning and sterilization of the entire system, the loop field shall be flushed and purged until free of dirt, debris, and air. During the chemical cleaning and sterilization process the supply and return run-outs shall be temporarily connected together at each heat pump location.

(4) After purging of the field loop the Contractor shall add an approved system cleaning solution at the recommended concentration to the entire system. Circulate the system with cleaner for the time recommended by the chemical manufacturer. After prescribed circulation time, flush the system until cleaner is removed.

(5) After chemical cleaning, the entire system shall be sterilized. Introduce a solution of sodium hypochlorite to achieve a chlorine residual of 25 to 50 ppm. Maintain this chlorine level for 12 to 24 hours. Flush out system until chlorine residual in system equals that of the makeup water.

(6) After the system has been completely cleaned and sterilized as specified herein, the individual heat pumps shall be connected permanently to the supply and return runouts and the system filled for operation under normal closed loop conditions. Within 48 hours of the completion of the sterilization implement a water treatment program to passivate all metal surfaces.

5. HVAC SYSTEM START-UP PROCEDURE

A. GENERAL

(1) The goal of this procedure is for a few units to run as much as possible with the coils as cold as possible to "wring out" the water and allow it to drain away in the condensate drain pans. Allowing all units to cycle on and off, running for short periods of time, does not dehumidify the air in the building. Starting the system without following the steps outlined will raise the relative humidity in the building and most likely cause condensation on some of the building surfaces and HVAC system that the Contractor will be responsible to correct.

(2) The high humidity and condensation occurs in school buildings at start up primarily because the building is only partly occupied (or not occupied) when the HVAC system is started. Most people believe that the answer to this problem is to turn the thermostats down very low. The assumption is that cold air will not hold moisture. That is not true. What happens is that the thermostats are quickly satisfied thermally because there is very little cooling load on the building and the cooling equipment. The terminal units then only have to run for a very short period of time to keep the thermostats satisfied and the relative humidity of the air is in fact raising. The goal is to cause the moist air to pass over coils which are cooling it and drying it without allowing more moist air to be introduced into the building.

(3) To reduce the always present high humidity start-up problem, we have devised this start-up procedure that will minimize the adverse effects of the start-up. As the building sits at start-up, all of the walls, floor, and ceilings are saturated with moisture from the air and also moisture is being released from the drying paint and curing concrete and mortar.

(4) The following procedure will slowly bring down the temperature and humidity in the lightly loaded building. It will also allow the HVAC equipment to more closely match the actual building load without students and equipment in use.

To reach these goals we require the following:

(1) Set 1/3 of the units (approximately every third unit) on 74°F (no lower). Set the other thermostats for a cooling setpoint of 90°F so the units will not cool. Override the controls so that the fans in all units will circulate air.

(2) Leave all of the interior doors open to allow the air to mix throughout the building.

(3) Close all exterior windows and doors.

(4) Turn off all exhaust fans and outside air units. Outside air unit exhaust and outside air dampers shall be closed.

(5) Leave all of the lights on in the building to provide a cooling load.

(6) Provide portable electric heaters or dehumidifiers in any room that shows signs of condensation.

Here is a list of things you should not do:

(1) Do not prop the exterior doors open during construction or while moving in furnishings.

(2) Do not start all of the units until students are starting school. When students start school the normal setpoints, schedules, and fan cycling shall begin.

END OF SECTION

SECTION 23 43 00 - REGISTERS, GRILLES, DIFFUSERS & LOUVERS

1. REGISTERS, GRILLES AND DIFFUSERS

   A. GENERAL

      Alternate R, G & D selections, other than manufacturers and models listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Price,Titus, Metalaire, Carnes, Anemostat, Kruegar, and Tuttle & Bailey. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. If Architect elects not to select color, all colors shall be off-white. Factory color samples shall be submitted with shop drawings.

   B. SELECTION

      Refer to the Selections Scheduled on the Drawings.

2. LOUVERS

   A. GENERAL

      Alternate louver selections, other than manufacturer and model listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Ruskin, Air Balance, Airline, Airstream, Louvers and Dampers and Penn. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect unless scheduled otherwise.

   B. LINTELS

      Provide lintels above all louvers as required. Refer to the lintel schedule provided by the Structural Engineer for all additional support required at wall penetrations.

   C. SELECTION

      Refer to the Selections Scheduled on the Drawings.

END OF SECTION

SECTION 23 44 00 - SHEET METAL AND FLEXIBLE DUCT

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's HVAC Duct Construction Standards, Metal and Flexible, and its subsequent addenda. HVAC duct systems shall be fabricated and installed in accordance with the SMACNA duct construction standards (SMACNA-HVAC and SMACNA-Seismic) including Appendix B of the Seismic Restraint Manual Guidelines for Mechanical Systems. These references and plate numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging, accessories, etc. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

2. PRESSURE VENTS

   A. Provide a pressure relief vent in the supply air ductwork at each air handling unit. It shall be located between the fan outlet and the first manual or automatic (i.e., fire, fire smoke, or any motorized) damper or closure device. It shall be sized to relieve the duct air pressure below the rated pressure construction of the ductwork and above the working pressure of the fan. Provide a vacuum relief vent in the return and/or outside air ductwork at each air handling unit. It shall be located between the air handling unit casing and the first manual or automatic damper or closure device. It shall be sized to relieve the duct vacuum below the rated construction of the ductwork and above the working negative pressure of the fan. Automatic fan shutdown upon damper closure shall not be an acceptable protection for either overpressure or vacuum conditions. All duct relief dampers shall be of the automatic resetting type unless otherwise noted.

3. FILTER RACKS

   A. If separate filter grilles are specified for an HVAC unit the Contractors shall remove any unit mounted filters and blank off the unused filter access opening with sheet metal and seal air tight.

4. WALL PENETRATIONS

   A. Where ducts penetrate interior or exterior walls, the walls shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

5. PROTECTION DURING CONSTRUCTION

A. All ductwork openings shall be covered during construction to prohibit dust and dirt from entering the installed ductwork, air handling unit, terminal devices, etc. Provide temporary filters on all return grilles and duct openings if the units are running prior to the building being satisfactorily cleaned. The Contractor shall pay for duct cleaning if precautionary measures are not taken.

6. LOW VELOCITY DUCTWORK

A. General (Low Velocity)

(1) Double turning vanes shall be installed in all square turns and in any other locations indicated.

(2) Provide "spin-in" type fittings for all round ducts serving supply air diffusers where the duct branches off the rectangular duct main. The spin-in fitting shall not penetrate farther than 40% into the duct width.

(3) Cross-break all ducts where any duct section dimension or length is 18" or larger.

(4) Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.

(5) Splitter dampers shall be provided in all rectangular supply air duct tees. Damper blade operator shall extend a minimum two inches thru the insulation.

(6) Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc.

(7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do not suspend ducts from perlins or other weak structural members where no additional weight may be applied. If in doubt, consult the structural engineer.

(8) Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.

(9) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with "Duct Seal 321". Apply per manufacturer's recommendations.

(10) Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.

(11) All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.

(12) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, coils, VAV boxes, fan sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(13) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.

(14) The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.

(15) Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.

(16) All fans and other vibrating equipment shall be suspended by independent vibration isolators.

B. Materials (Low Velocity)

(1) Ductwork, plenums and other appurtenances shall be constructed of the following:

a. Steel sheets, zinc coated, Federal Specification 00-S-775, Type I, Class E & ASTM A93-59T with G-90 zinc coating or aluminum alloy sheets 3003, Federal Specification AA-A-359, Temper H-14.

b. Exposed ductwork in finished spaces such as gymnasiums, etc., shall be dual wall ductwork.

(2) Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the IMC and SMACNA HVAC Duct Construction Standards - Metal and Flexible, or as follows whichever is more stringent.

	ROUND DUCT	RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 12	26	UP TO 12	26
12 TO 18	24	13 TO 30	24
19 TO 28	22	31 TO 54	22

29 TO 36	20	55 TO 84	20
37 TO 52	18	85 AND ABOVE	18

(3) Flexible ductwork which is uninsulated shall be corrugated aluminum. Use flexible ductwork only where indicated. No sections shall be greater than five feet in length. Ductwork shall be UL rated and in accordance with IMC.

(4) Insulated Flexible Duct (Use Only Where Indicated)

a. Owens/Corning or equivalent, 1 ½'' inch thick fiberglass insulation; flexible liner; with aluminum pigment vinyl vapor barrier facing. Insulated flexible duct shall meet Fire Hazards Standards of NFPA 90A and IMC, flame spread not to exceed 25, smoke develop and fuel contributed not to exceed 50 when tested in accordance with ASTM-E84. Minimum R-value of 6.0, tested in accordance with ASTM C177.71. Flexible duct may be used only for runouts and no sections shall be more than five feet in length.

b. When flexible duct is located in areas where it will be visible because the ceiling allows views to the ductwork above, the flexible duct shall be black. The black color shall be factory coloring and not field applied.

c. Flexible duct shall not be used in areas where there is no ceiling.

C. Double Wall Low Velocity Ductwork

(1) Install Double Wall Ductwork in the following areas:

a. Gymnasium
b. Cafeteria
c. Above areas with partial ceilings or clouds
d. Anywhere supply ductwork is installed exposed to view in spaces (other than mechanical rooms)
e. At all other locations indicated on drawings
f. Media Center

(2) Prior to purchase/shipment of the ductwork, manufacturer shall provide as part of the submittal process scaled, field coordinated Autocad drawings of the complete system to be furnished. Drawings will indicate all system components including fittings, ductwork and manifolds. Drawings shall be available in an electronic format.

(3) Furnish and install where indicated double wall duct. The double wall duct shall be Eastern Sheet Metal, United McGill, Semco or approved equivalent. The duct shall have an inner shell, a 1-inch layer of fiberglass insulation and an outer pressure shell.

(4) Ductwork outer shell shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Any ductwork exposed to view shall be constructed of G90

galvanized steel, 20 gauge, and shall be supported as required with aircraft cables and self-tightening locks. Ductwork shall be constructed as specified in LOW VELOCITY DUCTWORK.

(5) Inner shell for spiral pipe shall be a perforated inner liner. The inner liner shall have 3/32" perforation with an overall open area of 23%.

(6) Inner shell for fittings shall be galvanized steel. All fittings shall be manufactured by the same manufacturer as the spiral pipe. Fittings shall be constructed a minimum of 22 Ga.

(7) The fiberglass liner shall have a maximum thermal conductivity (k) factor of 0.27 btu per hour per square foot per degree Fahrenheit per inch thickness at 75 degree F ambient temperature.

(8) All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which shall keep the inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

(9) All grille and register taps shall be factory manifolded. Field installed taps will not be allowed. Manifolded taps may be tack welded and caulked for appearance. Only taps for grilles and registers may be provided this way. All other fittings shall be full body welded.

D. Miscellaneous (Low Velocity)

(1) Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A; neoprene coated glass fabric; 20 oz. for low velocity ducts secured with snap lock.

(2) Turning Vanes: Barber-Colman, Titus, Waterloo, or equivalent; fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.

(3) Air Extractors: Metalaire Model 102-1 Carnes, Titus, Barb-Air or approved equivalent. Provide with operating hardware by Ventfabrics, Inc. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

(4) Splitter Damper: Splitter damper shall be constructed of 16 gauge galvanized steel. Provide with operating hardware by Ventfabrics, Inc. to include damper blade bracket, ball joint bracket and operator shaft. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

(5) Access Doors; In Ductwork: In ducts where indicated or where required for serving equipment, fabricated according to SMACNA recommendations and be equivalent to those manufactured by Air Balance, Vent Products or other approved equivalent. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils (water, electric, steam, etc.), and downstream side of VAV boxes and CAV boxes. Access doors for rectangular ducts shall be

16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length.

(6) Access Doors; In Ceilings or Walls: Titus, Krueger, Milcor or approved equivalent with key locks.

a. In mechanical, electrical or service spaces. 14 gauge aluminum brushed satin finish, 1" border.

b. In finished areas.
14 gauge primed steel with 1" border. To accept the architectural finishes specified for the space.

Provide where required to access equipment, dampers, valves, filters, etc.

(7) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air volume dampers. Frames shall be 4" x 1 "x 16 gauge galvanized steel. Blades shall be 16 gauge galvanized steel, maximum of 6" wide. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(8) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air Round Damper. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20 gauge steel, 7" long. Damper blades shall be 20 gauge galvanized steel. Axle shall be 3/8" diameter steel. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(9) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3 hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16 gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. All fire dampers shall be dynamic. Static fire dampers are not allowed. Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2 hour rating or Ruskin Type DIBD 23 for a 3 hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.

7. HIGH VELOCITY DUCTWORK

A. Application (High Velocity)

(1) Variable air volume box inlet sized ductwork branches/run-outs serving single Variable Air Volume terminals shall be high velocity single wall ductwork.

(2) Constant air volume box inlet sized ductwork branches/run-outs serving single Constant Air Volume boxes shall be permitted to be high velocity single wall ductwork.

B. General (High Velocity)

(1) Provide flexible connectors at inlet and outlet of air handling equipment to accommodate a minimum of three times the operating pressure of the system.

(2) Duct dimensions indicated are required inside clear dimensions.

(3) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with Hardcast "DT" tape and Hardcast "RTA-50" adhesive installed in strict accordance with manufacturers recommendations.

(4) Ductwork shall be installed per SMACNA Medium or High Pressure Manual, whichever is applicable. (Latest Edition shall apply.)

(5) All hanger straps shall be 18 ga. minimum with reinforcement angles installed in strict accordance with SMACNA. Flat oval ducts shall be installed with 2"x2"x1/4" angles on top and bottom ducts 18" wide and larger. Use 1"x1"x3/16" angles on ducts under 18" wide.

(6) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA or the duct manufacturer, and/or as indicated. Test openings shall be placed at the discharge of all air handling units and at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(7) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panels at each fire damper located and sized so as to allow hand reset of each fire damper. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. Where access doors are installed in insulated ductwork, the access door shall be the insulated type.

C. Materials (High Velocity Single Wall)

(1) All round and oval high velocity ductwork shall be United McGill "Uni-Seal" or "Uni-Weld" ductwork or Semco, Dixie, Eastern Sheet Metal, Langdon, or approved equivalent as required by pressure rating of the system.

(2) Ductwork shall be spiral, lock-seam type and be constructed of galvanized steel.

DIAMETER (Or Equivalent Round Diameter For Oval Ducts)	METAL THICKNESS

3-14 Inches	26 Ga.
15-26 Inches	24 Ga.
27-36 Inches	22 Ga.
37-50 Inches	20 Ga.
52-60 Inches	18 Ga.

All duct fittings shall be fabricated by duct manufacturer. Duct fittings shall be minimum 20 gauge. All fittings shall be a minimum of one gauge heavier than the pipe size.

D. Air Leakage Testing of the Ductwork Systems

(1) It is the intent of this section to insure the ductwork installed has minimal air leakage.

(2) Air leakage testing shall be accomplished by an AABC or NEBB certified company. Refer to the Test & Balance specifications.

(3) It is the intent to test all ductwork. The duct systems which will require testing are as follows:

a. All supply air duct systems

b. All return air duct systems.

c. All exhaust air duct systems.

d. All outside air duct systems.

(4) Do not insulate the supply air systems prior to testing.

(5) The maximum allowable supply and outside air leakage rate is 2.5%**.)** of the systems design CFM when the ductwork is pressurized to 2.5" WG (Therefore, if a supply air system is tested, and the supply air fan rated capacity is 10,000 CFM, the allowable leakage is 250 CFM.) The maximum allowable return air and exhaust air leakage rate is 2.5% of the system design when the ductwork is pressurized to 1.50"WG.

(6) The entire outside air ductwork system shall be tested. On the VAV systems, the ductwork upstream of the VAV boxes shall only best tested.

(7) All exhaust air sheet metal ductwork associated with the system shall be tested. Flexible ductwork shall not be tested. Cap the main duct prior to the central equipment fan connection. Also cap the branch ducts which serve the diffusers, after the round branch air volume with sheet metal caps. Seal caps well to damper to avoid air loss at this location. This air loss, from the caps, is included in the noted leakage rate.

(8) The noted allowable leakage rate is the total allowable. It shall include leakage associated with the following:

a. All ductwork as described in above paragraphs.

b. Access doors

c. Volume dampers

d. Fire dampers

e. End caps used to seal ducts

(9) If any duct system fails a test, the contractor shall reseal the system. It shall then be retested until the duct system meets the leakage allowment at no additional cost to the owner.

(10) Carefully select the ductwork construction requirements and the type of duct sealant to be used as required to meet the leakage allowances. The sheet metal duct pressure classification is a minimum only. The contractor shall select the appropriate sheet metal pressure classification, duct sealant class and duct sealant materials to meet the project air leakage allowances.

8. KITCHEN RANGE HOOD EXHAUST DUCT

A. Ducts shall be constructed of 18 gauge stainless steel with liquid tight continuous external weld of all seams and joints where exposed. Where ducts are concealed, they shall be constructed of 16 gauge black steel with liquid-tight continuous weld of all seams and joints. Inside laps on duct joints shall project in a direction against the air flow.

B. Ducts shall be so constructed and sloped as to provide suitable drainage of grease to a collection point. At the base of each vertical riser, a residue trap shall be provided with provisions for cleanout.

C. Hand holes for inspection and cleaning purposes, equipped with tight fitting sliding or swinging doors and latches, shall be provided in horizontal sections of exhaust ducts. Such openings shall be at the sides of the horizontal run in order to prevent dripping of residue. Spacing of such openings shall not exceed 20 feet and shall be located at all offsets. Openings shall have a minimum dimension of 20" in width with a height equivalent to the duct height minus one inch.

D. Shop drawings of the kitchen rangehood exhaust ductwork shall be made and submitted to the appropriate reviewing agency. Any fees associated with this submittal shall be borne by this Contractor.

9. DISHWASHER EXHAUST DUCT

A. All exposed exhaust duct shall be 22 gauge stainless steel duct with liquid tight continuous external weld of all seams and joints. All concealed exhaust duct shall be 24 gauge aluminum with liquid tight joints. Provide dielectric connection between steel and aluminum ductwork. All ductwork shall be sloped so as to drain back toward the dishwasher.

10. DRYER VENT

A. Provide a dryer vent at all dryer locations indicated on the plans. Duct shall be 22 gauge aluminum with all joints sealed. Provide an aluminum wall or roof cap as recommended by the appliance

manufacturer. Vent shall not exceed the equivalent length required by the dryer manufacturer or the IMC.

END OF SECTION

SECTION 23 51 00 - MOTOR STARTERS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. MOTOR STARTERS-GENERAL

   A. Where motor starters are required for mechanical equipment they are to be the responsibility of the Contractor furnishing the equipment as outlined herein.

   B. Motor starters shall be furnished by the Equipment Supplier with his equipment. Coordinate all requirements for starters with equipment suppliers and other trades.

   C. Motor starters shall be NEMA style. I.E.C.-style starters are not to be provided. Their sizing and installation shall be coordinated with the equipment manufacturer's requirements and in accordance with the National Electrical Code.

   D. Unless otherwise noted, provide combination starter/disconnects for all equipment requiring a starter.

2. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

   A. All mechanical equipment shall be provided for single point electrical connection unless specifically noted to the contrary. Refer to schedules and other sections of these specifications for further requirements. It is the responsibility of the Contractor to coordinate the electrical characteristics of all equipment with the electrical provisions indicated on the Contract Documents. The Contractor shall notify the Engineer in writing ten calendar days prior to bid of any discrepancy so a written clarification by Addendum may be made. If such notice is not given, the Contractor shall be responsible for any and all costs or delays associated with any changes required. Specification of equipment characteristics made during review of shop drawings shall not relieve the Contractor of this responsibility.

   B. The equipment manufacturer shall provide internally mounted fuses with his equipment, as required, to comply with the U.L. listing on the equipment name plate. (i.e., hermetically sealed compressors or equipment with name plate data that recommends or requires fuse protection.) See also, National Electrical Code, Article 440, and other applicable sections of the N.E.C.

   C. It is the Contractor's responsibility to furnish and install fusible or non-fusible disconnect switches or circuit breakers for disconnecting means as required by the Code for all electrically powered equipment. All power wiring from source, thru disconnecting means and motor starters to motor terminals or equipment junction box is to be furnished and installed by the Contractor. Each separate contractor engaged for the project shall coordinate with all other trades to ensure all necessary equipment and labor is included for fully functioning mechanical systems, installed per code requirements. Unless otherwise notes, provide combination starter/disconnects for all equipment requiring a starter.

   D. Final electrical connection of equipment shall be verified for proper voltage requirements in conjunction with the motor nameplate patch and actual wiring configuration. Any costs associated with damage to appliances motors, equipment, etc., connected to incorrect supply voltage shall be borne by the Contractor.

E. Refrigeration condensing units with internal compressors shall be furnished with integral starter. The Contractor is to furnish and install a fusible disconnecting mains with fuses sized to motor nameplate requirements. Coordinate wiring, mounting and style of disconnect switch at unit in field.

F. All interlock or other control wiring, unless specifically noted otherwise, is the responsibility of the Contractor.

G. All equipment shall be suitably enclosed. All enclosures for equipment shall be rated and approved for the environment in which it operates. (i.e., NEMA 1, NEMA 3R, NEMA 7, NEMA 12, etc.) Verify the requirement with the installation condition if not indicated on the plans.

H. Observe the following standards for manufacturers of equipment and selection of components.

(1) Starters, control devices and assemblies: NEMA, U.L. - (I.E.C. style not acceptable)

(2) Enclosures for electrical equipment: NEMA, U.L.

(3) Enclosed switches: NEMA, U.L.

(4) All electrical work, generally: National Electrical Code

(5) All electrical work in industrial occupancies: J.I.C. standards

(6) All electrical components and materials: U.L. listing required.

I. Where required, the Contractor is to provide mounting rails or channels to install starters with code-required clearances. Framing shall be solidly anchored by welding expansion shields in masonry or other approved anchorage. Frames are to be constructed of steel angles or pre-manufactured channel systems such as Unistrut, Kindorf or B-Line Company. Framing material shall be pre-finished with corrosion-resistant material or painted with two coats corrosion-resistant oil-based enamel.

3. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 1/2 H.P OR LESS

A. This section describes requirements for small mechanical equipment such as (but not limited to) package terminal heating/cooling units, (water source heat pumps, etc.) VAV boxes, unit heaters, vertical and horizontal unit ventilators, exhaust fans, in-line fans, fan coil units, cabinet heaters and the like.

B. Small equipment with motor(s) of 1/2 H.P., single phase or less are generally not required to be furnished with NEMA-style starter(s), unless otherwise noted.

C. For such equipment, provide integral contactor or horsepower-rated relay where controlled by thermostat or other type of switch. Contactors or relays shall be as recommended by the manufacturer of the equipment, suitable for the service duty.

D. Provide transformer within unit as required to derive low voltage A.C. for thermostat control or derive from temperature controls panel, if available.

E. Provide internal fusing for unit motor and other loads in fuse block or in-line fuseholder. See also Article 2-B, this Section.

F. Where externally-mounted disconnecting means is required and would be impractical, unsightly or inappropriate in the judgment of the Engineer, disconnects shall be located within the unit. These disconnects may be fusible H.P.-rated snap switches or manual starters with overload elements, as required. Locate this and other electrical equipment within enclosure where easily accessible behind access panel or door on unit, and as acceptable to the electrical inspector or local authority having jurisdiction. Refer to mechanical equipment schedules for further information.

G. Where fractional horsepower duplex pumps such as water circulators, sump pumps, etc. are provided, they shall be provided with alternators, cordsets, etc., as required for a complete installation.

4. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 3/4 H.P. OR LARGER

A. This section describes requirements for mechanical equipment such as (but not limited to) exhaust fans, larger air handling units, cooling tower fans, water source heat pumps, chilled or hot water pumps, D.X. roof-top units, air compressors and the like.

B. Provide premium efficiency motors.

C. Equipment provided with motor(s) of 3/4 H.P. and larger, single or three-phase are required to be furnished with starters suitable for the load(s) specified. It is recommended that starters be furnished integrally with or mounted on equipment for field wiring by the Contractor. Where starters are furnished separate from equipment, furnish templates or rough-in diagrams to the appropriate contractor for his use in installation.

D. All starters shall be size 0 minimum. They shall be constructed and tested in accord with latest edition of NEMA standards. All starters shall be across-the-line magnetic type, unless indicated otherwise. On motors of 20 H.P. or greater rating, the supplier shall provide starters capable of limiting inrush currents. These shall be of the wye-delta, reduced voltage open-transition type, or electronic controlled, as required. Do not utilize closed transition starters unless specifically indicated.

E. Magnetic starters shall be furnished with the following characteristics and accessories as a minimum. See other sections of these specifications and mechanical schedules for further requirements.

(1) Contacts shall be silver-alloy, double-break type. Contacts shall be replaceable without removal of wiring or removal of starter from enclosure. Number of contacts shall be as required for service indicated. Contacts shall be gravity dropout type, positive operation.

(2) Coil voltage shall be 120 volts, A.C., 60 HZ or less, as required to suit control systems available voltages. Coils shall be of molded construction, rated for continuous duty. Provide coil clearing contact as required.

(3) Provide control transformer of adequate K.V.A. as required on all starters with line-to-line voltages higher than 120 volts A.C. Provide fuse block and slow-blow fuse to protect control transformer per NEMA, N.E.C. and U.L.

(4) Provide hand-off-auto selector switch in face of starter, wired into hand and off switch positions. Auto position (if needed) to be field wired as indicated on plans or schedules for automatic control. Provide a green run pilot light.

(5) Provide NEMA Class 20 resettable overload relays, accurately sized to the motor nameplate rating of the motor served and the temperature differential between motor and controller. Overloads shall be easily replaceable, and resettable without opening enclosure, via a push button or similar means. Class 10 or Class 30 overloads may be used, depending on the type of anticipated service.

(6) Provide at least one N.O. and one N.C. auxiliary contact (field-convertible to opposite operation) with each starter. Refer to mechanical details or schedules for additional requirements, if any. All starters shall have space for two additional single-pole contacts.

(7) All starters shall be thru-wiring type.

(8) Provide phase failure sensing relay to open starter coil circuit (on loss of one or more phases) on all three-phase starters controlling motors of 15 H.P. or larger.

(9) Provide power factor correction capacitors on motors of 15 H.P. or larger where predicted power factor based on manufacturer's data will fall below 0.90%. Capacitors shall be of the unit-cell type, in single enclosure with discharge resistors and tank overpressure circuit interrupter for safety.

5. REQUIREMENTS FOR WIRING

A. All wiring, including controls, interlock, miscellaneous power, sensors, thermostats, etc., shall be installed in metallic raceway systems that are in compliance with all Division 26 requirements of these Specifications, unless specifically noted otherwise. Open cabling systems will only be permitted where specifically permitted within the Division 26 Specifications and if less than 50 volts A.C. peak-to-peak or 50 volts maximum D.C.

B. Where open cabling is permitted, it shall be installed with proper support as specified in the Division 26 Specifications.

C. Where open cabling is permitted, and installed in environmental air plenum (return, relief, supply, etc.), the materials installed shall be in compliance with N.E.C. Articles 700, 725, 770 (for fiber optic), 780 and 800.

D. Where open cabling is permitted, it shall only be installed open in accessible spaces. Where concealed in walls, it shall be routed through raceways to outlet boxe(s) for the terminal device.

6. INVERTER DUTY MOTORS

A. Motors which are controlled by variable frequency drive shall be:

(1) NEMA MG-1 Part 31 rated for Inverter Duty.

(2) Furnished with shaft grounding kit for all motors:

a. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

END OF SECTION

SECTION 15900 - CONTROLS – DIRECT DIGITAL

1. GENERAL

A. The Contractor shall furnish all labor, materials, equipment and services required to provide a complete Web based temperature control system as specified and as shown on the plans.

B. Prior to the installation of or payment for any work, the Contractor shall prepare submittals which shall be reviewed by the Architect and Engineer. These submittals shall include a complete control diagram and sequence of operation of the entire system, plus engineering data on all devices used.

C. The Contractor shall be a licensed installer of HVAC temperature controls by a national temperature controls manufacturer. Acceptable manufacturers are Siemens, Johnson, or Honeywell. The installer shall have 5 years experience and installed a minimum of 8 systems of similar size. Their offices shall be within 100 miles of the project site.

D. The system herein specified shall be free from defects in workmanship and material under normal use and service if, within twelve (12) months from the date of acceptance by the Engineer, any of the equipment herein described is proved to be defective in workmanship or material, it will be adjusted, repaired, or replaced free of charge by the Contractor.

E. All equipment, unless specified to the contrary, shall be fully proportioning and adjustable. The Control System shall consist of all room thermostats, air stream thermostats, valves, damper operators, relays, freeze protection equipment, dampers, panels, and other accessory equipment not provided with the equipment to fill the intent of the specifications and drawings.

F. All units, controls, equipment, heat pumps, etc., and controls shall reset automatically when power is restored after an outage.

G. All control wiring concealed in walls and exposed in mechanical rooms, closets, etc., shall be in conduit. In the existing building, surface mount wiremold is acceptable where conduit cannot be installed in the block wall. Architect shall select color of wiremold. Provide plenum rated wiring where cable is concealed above ceilings. Do not paint wiring. The Contractor is responsible for protecting wiring from paint. Any painted cabling shall be replaced.

H. All dampers shall be capable of operating properly with the system pressures encountered. This shall include modulating and shut-off functions.

I. The Contractor shall also refer to the mechanical maintenance, HVAC equipment, and all other sections of the specifications for additional control requirements.

J. Provide smoke detectors and shut down control for all air handling units and combined air systems as required by the KBC and IMC Section 606.

K. All DDC controllers or control modules shall have covers to protect the circuit boards. All wiring shall be anchored securely within 6" of the controller.

L. Provide all control dampers, etc. not supplied with the equipment or required to accomplish the sequences specified.

M. The Contractor shall provide all refrigeration control and interlock wiring as recommended by the equipment manufacturer.

N. Wiring and required conduit in connection with the control system(s), including power wiring of any voltage, shall be installed by the Contractor. The Contractor may, at his option, engage the Electrical Contractor to accomplish this work. It is emphasized however, that the Contractor is finally responsible for all such work.

O. Electric power for the control panels, modules, unit controller, damper motors, etc., shall be derived from the building electric system. Power shall not be derived from the HVAC equipment power source or equipment low voltage transformers (internal or integral).

P. The electrical work required for the installation of the control system(s), shall be provided by the Contractor in accordance with all National and Local Electrical Codes. All wiring shall be concealed except in Mechanical Rooms. All electrical work specified under this division of the specifications shall also comply with Division 16 of these specifications.

Q. All exterior electrical work, equipment, etc. shall be waterproofed.

R. Controls system and all related components shall comply with ASHRAE Standard 135 (BACnet protocol).

S. This is a LEED project. Contractor shall provide cut sheets and manufacturer's product data for all thermal controls per EQ credit 6.2: Controllability of Systems, Thermal Comfort. Contractor shall provide cut sheets and manufacturer's product data for all thermal building & environmental control systems. Set point, changeover schedules, maintenance and operation instructions, and a maintenance and inspection schedule per EQ credit 7: Thermal Comfort.

2. OWNER'S TRAINING

A. The Contractor shall provide full instructions to designated personnel in the operation, maintenance, and programming of the system. The training shall be specifically oriented to the system and interfacing equipment installed. Twelve hours of Owner Training shall be provided at substantial completion, again after 6 months (four hours) and (four hours) again 1 year after substantial completion. The Owner Training shall include an overview of the entire HVAC system operation, temperature sensor setpoint manipulation, critical alarm training and graphics display overview. Subcontractors shall be present during Owner training sessions.

B. The Contractor shall provide a Sign-in Sheet and Meeting Minutes of the training. The Contractor shall also video tape the initial training sessions. Complete Operations and Maintenance Manuals shall be reviewed by the Contractor during training.

3. CONTROL SYSTEM CHECKOUT AND TESTING – BY CONTROLS CONTRACTOR PRIOR TO DEMONSTRATION AND ACCEPTANCE

A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any of all startup testing.

(1) Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 15900.
(2) Verify that control wiring is properly connected and free of shorts and ground faults.
(3) Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
(4) Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
(5) Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
(6) Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated. Submit log to Engineer for review.
(7) Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
(8) Alarms and Interlocks.
    a. Check each alarm with an appropriate signal at a value that will trip the alarm.
    b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
    c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

4. CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Control System Checkout and Testing. Provide Engineer with log documenting completion of startup tests. Submission of log is required before Demonstration and Acceptance may begin.

(1) Engineer will be present to observe and review system demonstration. Schedule with Engineer at least 14 days before system demonstration begins. Systems balancing shall be complete prior to demonstration, coordinate scheduling with TAB agency accordingly.
(2) Demonstrate actual field operation of each sequence of operation as specified in these specifications. Provide at least two persons for one day each (16 man hours) to demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Specified on site time does NOT include time necessary to correct deficiencies.
(3) Demonstrate complete operation of operator interface.
(4) Demonstrate all alarms, including external alarms to Owner selected pagers, phones, e-mail accounts, etc. Also demonstrate fire alarm system interface.
(5) Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

(6) Provide all required tools to perform system demonstration and point calibration (drills, duct plugs, thermometers, hygrometers, hand-held carbon dioxide sensors, aerosol test smoke, 2-way radios, water probes, DP sensors for water and air, etc.)

B. Acceptance.

(1) After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
(2) System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in these specifications. Warrantee will not start until acceptance by Owner and Engineer.

5. EQUIPMENT-Additionally refer to 17. AUXILIARY CONTROL DEVICES for further requirements and other equipment in this specification section.

A. CONTROL PANEL(S)

(1) Each system shall be provided with a local panel for mounting of all relays, switches, controllers, and thermometers associated with that system. Where one cabinet will not accommodate all the equipment necessary for one system, a second cabinet shall be mounted and bolted adjacent to it. Cabinets shall be provided with a 2/3's door. All devices shall be provided with lamacoid plastic nameplates for identification. Panel to be located in lower level mechanical room.

B. THERMOSTATS

(1) General

a. All thermostats are to be provided by the temperature and controls contractor.
b. All thermostats shall have an LED display and button for warmer and cooler. This control shall allow the space occupants to reset the temperature up or down a predetermined amount. This amount or no amount at all, shall be settable thru the BAS.
c. The thermostat shall have an unoccupied override button and an integral communications port.
d. The thermostat shall have no integral thermometer.
e. All thermostats provided for the project shall be similar in size and appearance.
f. Provide tamper-proof guards for all wall mounted thermostats where shown on plans.
g. All thermostats shall be flush mounted with the wall recessed into the wall as a tamper resistant measure. Provide back boxes and utility boxes as required. Thermostat shall be designed for above-mentioned mounting style.
h. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
i. Thermostats shall provide temperature deadband of 5° F as required by IECC 2003.

C. DAMPERS

(1) Several louvers of practical widths shall be provided for larger dampers. Modulating dampers shall have opposed blades. Dampers shall have edge and end seals. Dampers shall be Ruskin CD-60 or better. Maximum leakage rate shall be 2 CFM per square foot at 1" W.G. pressure differential for dampers greater than 12" wide. Leak rate for dampers 12" and less shall be 3 CFM per square foot. NOTE: Do not mount outside air dampers so close to water coils, piping, etc., that freeze-up may occur due to a leaky damper.

D. RELAYS AND SWITCHES

(1) Relays and switches shall be of the positive and gradual acting type and shall be furnished and installed as required for the successful operation of the system. All switches shall have suitable indicating plates.

E. VALVES

(1) All valves shall be of the fully modulating and silent type unless otherwise specified. They shall provide accurate control of the heating or cooling medium under all load conditions. All valves 2-inches or smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2 inches and larger shall have iron bodies, brass or bronze trimming with flange ends. Valves shall be normally open or normally closed as required. Valves shall be installed with the stem in the upright position or as recommended by the valve manufacturer.

F. BUILDING ENERGY AND GREEN STORY DASHBOARD

The following vital sign pages generated/created by a Computer Graphic Artist sub-contracted by this Contractor shall be displayed. The quality of graphics shall be equivalent to the energy dashboard by Quality Automation Graphics. Example:

- http://qagraphics.com/energy-efficiency-education-dashboard.html

1. The Vital Signs Page shall be a flash or equivalent interactive interfaced targeted toward students. The page shall be a embedded html page and all content shall be organized for future upgrades and shall reside on the school file server and/or BAS computer. Provide as I.P. Address for intranet and internet connectivity to provide real-time data display as all pages. Provide Gateway interface coordinated with BAS programming language.

2. Provide a graphic that displays all of the LEED credits achieved and link to simple description of the credit requirements. See attached LEED checklist.

3. Energy Usage and production

    - Title
    - Floor plan animated color graphic.
        - Provide graphics showing what systems utilize energy and what systems are producing energy for the building
        - Provide a working graphic that displays how the geothermal system works along with actual temperatures of the piping loop entering and leaving the building.
    - Outside air temperature & humidity.

4. Low Emitting Materials
   - Custom color interactive photo graphic with building materials.
   - Show a room with walls, flooring to touch and display information on the Low Emitting Materials utilized for LEED Credits 4.1, 4.2, 4.3, 4.4
   - Coordinate the room displayed with the owner

5. Green Tips
   - Main index thumbnail page with touchable thumbnail links to each page 20 tips in total. The 20 graphics pages with navigation links back and to main index page. The Architect and Engineer shall provide the topic for each page and the Contractor shall develop the page. Each page must be approved prior to implementation.

6. PV Array

   - Energy Introduction:
     - Provide graphic of Photovoltaic cells
     - Provide real-time KW production
     - Provide weekly KWH production.

G. WEATHER STATION

(1) Provide a weather station including a roof mounting system. Coordinate mounting with the roofing manufacturer and installer.
(2) The weather station system shall be a Weather Bug Weather Station, Davis instruments vantage pro 2, or approved equivalent that shall include the hardware, software, and curriculum integration components intended for use in a K-8 classroom setting. The system shall include the following.

a. Wind Sensor
b. Sensor shelter to measure temperature, relative humidity, heat index, wind chill, pressure, dew point and wet bulb temperature.
c. Rain Gauge
d. Lightning sensor
e. High definition camera with 1280x720 pixels and full 16:9 aspect ratio.
f. Network Integrator- Systems shall be IP enabled that transmits and stores weather data. Coordinate installation of network outlet with the weather station.
g. Back-up battery- 72 hour life.

(3) Initial installation shall include all costs associated with software licenses. There shall be no reoccurring annual license fees.
(4) Software and communication shall be provided to a minimum of 5 computers to be selected by owner.

6. DESCRIPTION

A. General: The control system shall be as indicated on the drawings and described in the specifications.

B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.

C. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

D. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.

E. Communication between the control panels and all workstations shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.

F. The documentation is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions and sequences shown.

1. WEB BROWSER CLIENTS

(1) The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Firefox™, or Safari™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

(2) The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

(3) The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

(4) The Web browser client shall support at a minimum, the following functions:

a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

c. HTML programming shall not be required to display system graphics or data on a Web

page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

d. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

e. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

(a) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

(b) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

2) Commands to start and stop binary objects shall be done by selecting the appropriate command from the pop-up menu. No entry of text shall be required.

3) View logs and charts.

4) View and acknowledge alarms.

5) Setup and execute SQL queries on log and archive information.

(5) The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

(6) Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2. ONSITE RESPONSIBILITY

A. Project Management Services: The building automation contractor shall have a project manager assigned to this project and shall attend all pre-construction and construction progress meetings. The project manager shall supervise the installation of the complete temperature control system and shall be available to the mechanical contractor to answer any questions related to the installation and operation of 100% outside air units with energy recovery, ventilation fans, Water Source VRF Systems, VAV/CAV boxes, Water Source Heat Pumps, etc, and temperature control system.

B. Owner Training Services: The building automation contractor shall provide the specified owner-training services for the controls furnished under this specification section. This contractor shall assemble representatives from all of the equipment and control device vendors and perform the owner training with their assistance. The temperature control contractor representative shall be present during all owner training of the VRV units, 100% outside air units with energy recovery, water source heat pump, VAV/CAV boxes, ventilation fans, hydronic pumping systems etc., and temperature control system.

3. QUALITY ASSURANCE

A. System Installer Qualifications

1. The Installer shall have an established working relationship with the Control System Manufacturer of not less than six years.

2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

3. The installer shall have an office within 100 miles of the project site and provide 24-hour response in the event of a customer call.

4. The list of acceptable manufacturers applies to operator workstation software, controller software, the custom application programming language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

B. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.

2. National Electrical Code -- NFPA 70.

3. Federal Communications Commission -- Part J.

4. ASHRAE/ANSI 135-1995 (BACnet)

5. EIA 901.2 (LonTalk)

C. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 5-years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.

4. SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the request.

2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.

3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.

4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior 60 seconds.

5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciation. All workstations on the network shall receive alarms within 5 seconds of each other.

9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

Table I **-- Reporting Accuracy**

Measured Variable	**Reported Accuracy**
Space temperature	±0.5°C [±1°F]
Ducted air	±1.0°C [±2°F]
Outside air	±1.0°C [±2°F]
Water temperature	±0.5°C [±1°F]
Delta-T	±0.15°C[±0.25°F]
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air pressure (space)	±3 Pa [±0.01 "W.G.]
Water pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM

Carbon Dioxide (CO_2) ± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)
Note 2: for both absolute and differential pressure
Note 3: * not including utility supplied meters

5. SUBMITTALS

Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications. An electronic copy shall be provided for review. All shop drawings shall be provided to the Owner electronically as pdf file formats.

Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the contractor from furnishing quantities required for completion.

Provide the Engineer and Owner, any additional information or data that is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.

Submit the following within 60 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
2. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
3. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
4. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:

    a) Building Controllers
    b) Custom Application Controllers
    c) Application Specific Controllers
    d) Operator Interface Computer
    e) Portable Operator Workstation
    f) Auxiliary Control Devices
    g) Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.
    h) Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
    i) Points list showing all system objects, and the proposed English language object names.
    j) Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.

k) Provide a BACnet Product Implementation Conformance Statement (PICS) for each BACnet device type in the submittal.
l) Color prints of proposed graphics with a list of points for display.

Project Record Documents: Upon completion of installation submit one copy of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .DWG or .DXF drawing files shall also be provided.

2. Testing and Commissioning Reports and Checklists.

3. Operating and Maintenance (O & M) Manual - These shall be as built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:

   a) Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
   b) Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
   c) Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
   d) Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
   e) A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.
   f) One set of electronic media containing files of all color-graphic screens created for the project.
   g) A list of recommended spare parts with part numbers and supplier.
   h) Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.
   i) Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.
   j) Licenses, Guarantee, and Warrantee documents for all equipment and systems.
   k) Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) time between tasks, and task descriptions.

Training Manuals: The Contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer and shall be completed at least 3 weeks prior to first class.

6. WARRANTY

A. Warrant all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

4. The system provider shall provide a web-accessible Users Network to give the Owner access to question/answer forum, graphics library, user tips, upgrades, and training schedules.

7. OWNERSHIP OF PROPRIETARY MATERIAL

A. All project developed hardware and software shall become the property of the Owner. These include but are not limited to:
1. Project graphic images,
2. Record drawings,
3. Project database,
4. Job-specific application programming code,
5. All documentation.

8. OPERATOR INTERFACES

A. Graphical User Interface Computer-Laptop

1. Contractor shall supply a Portable Operator Terminal, all necessary software, and interfaces to provide for the uploading/downloading of controller databases and programs, monitoring of all network variable types, including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules.

2. Provide laptop personal computer including software configuration tools that shall be capable of accessing all system data. This device may be connected to any point on the system network or may be connected directly to any controller for programming, set-up, and troubleshooting.

3. The Portable Operator's Terminal shall be a laptop including all software and hardware required. The laptop shall contain a minimum:

   a. Intel Core i7 Processor 2.8 GHz minimum, 6 MB cache minimum
   b. 8.0 GB DDR3 Memory
   c. 1TB Hard Drive, 7200 RPM
   d. CD-RW/DVD
   e. Windows Operating System (Version 8 or newer)
   f. 15" minimum color display with minimum 1920 x 1200 resolution
   g. AMD Radeon HD 7730M 2GB
   h. Wireless LAN Card
   i. (2) USB Ports

4. Locate laptop in Mechanical Room-Central 2101. Locate the Laptop in a fold-out wall cabinet.

B. Workstation information access shall use the BACnet Protocol. Communication shall use Annex J of ASHRAE Standard 135-95. Local connections of the workstation shall be on ISO 8802-3 (Ethernet). Remote communications shall use either the BACnet Point to Point Physical/Data Link Layer Protocol or IP over Point to point (PTP).

9. SYSTEM SOFTWARE

1. Operating System. Furnish a commercially available, concurrent multi-tasking operating system. The operating system shall also support the use of other common software applications that operate under DOS or Microsoft Windows. The operating system shall be Windows Version 8 or newer.

2. System Graphics. The Operator Workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment. Graphics shall be capable of launching other PC applications.

   a) Custom Graphics. Custom graphic files shall be created with the use of commonly available graphics packages such as PC Paint. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF and JPEG. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as Designer, AutoCAD or Revit..

   b) Graphics Library. Furnish a complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library shall also include standard symbols for other equipment including fans,

pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

c) Engineering Units. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be: Standard Inch Pound.

10. SYSTEM APPLICATIONS:

Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation.

1. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any panel in the system. The storage of this data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel.

2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database from any system panel and store on magnetic media. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

3. System Configuration. The workstation software shall provide a graphical method of configuring the system. The user with proper security shall be able to add new devices, and assign modems to devices. This shall allow for future system changes or additions.

4. On-Line Help and Training. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. Provide an interactive tutorial CD, which will act as on-line training/help for the systems operator.

5. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time shall be set per operator password. All system security data shall be stored in an encrypted format.

6. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

    a) Alarm Reactions. The operator shall be able to determine what actions, if any, are to be taken, by object (or point), during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, texting, forwarding to an e-mail address, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. An object in alarm that has not been acknowledged within an operator specified time period shall be re-routed to an alternate operator specified alarm receipt device.

    b) Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.

    c) Analog Alarms. Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.

8. Trend Logs. The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. All trends shall start based on the hour. Each trend shall accommodate up to 64 system objects. The system operator with proper password shall be able to determine how many samples are stored in each trend. Trend data shall be sampled and stored on the Building Controller panel and be archived. Trend data shall be able to be viewed and printed from the operator interface software. Trends must be viewable in a text-based format or graphically. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.

9. Dynamic Graphical Charting. The operator shall be able to select system values to be charted in real time. Up to three values at one time can be selected for each chart. The type of chart (bar, line, 3-D, etc.) shall be selectable.

10. Alarm and Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. The operator shall be able to sort and filter alarms. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.

11. Object and Property Status and Control. Provide a method for the operator with proper password protection to view, and edit if applicable, the status of any object and property in

the system. These statuses shall be available by menu, on graphics, or through custom programs.

12. Clock Synchronization. The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks; daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.

13. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. The operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.

    a) Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

C. Workstation Applications Editors. Each PC workstation shall support full screen editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at the appropriate controller panels.

1. Controller. Provide a full screen editor for each type controller and application, that shall allow the operator with proper password to view and change the configuration, name, control parameters, and system set-points.

2. Air System Equipment Coordination. Provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations. This shall include the coordination of VAV boxes with their associated Air Handling Equipment.

3. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

    a) The language shall be English language oriented and be based on the syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, the programming language can be graphically-based using function blocks as long as blocks are available that directly provide the functions listed below, and that custom or compound function blocks can be created.

    b) A full screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete code from the custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

c) The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

d) The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and to observe any intermediate values and or results. The debugger shall also provide error messages for syntax and execution errors.

e) The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f) The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and xy. The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.

g) The programming language shall have pre-defined variables that represent clock time, day of the week, and date. Variables that provide interval timing shall also be available. The language shall allow for computations using these values.

h) The programming language shall have ability to pre-defined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the values of BACnet objects in the system.

11. SYSTEM SOFTWARE

A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.

B. System Security

1. User access shall be secured using individual security passwords and user names.

2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.

3. User logon/logoff attempts shall be recorded.

4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

1. Weekly Schedule. Provide separate schedules for each day of the week.

2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.

3. Holiday Schedules. Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

4. Optimal Start/Stop. The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

D. Remote Communications. The system shall have the ability to email or text alarm message. The system shall use a priority array to determine which alarms to send out and to whom.

12. BUILDING CONTROLLERS

A. General. Provide Building Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global strategies described in System software section.

2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. The controller shall provide a communications port for connection of the Portable Operators Terminal.

4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

5. Controllers that perform scheduling shall have a real time clock.

6. Data shall be shared between networked Building Controllers.

7. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

a) Assume a predetermined failure mode.
b) Generate an alarm notification.

8. BACnet. The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in these BIBBS:

DS-RP-A,B
DS-RPM-A,B
DS-WP-A,B
DS-WPM-B

B. Communications. Each Building Controller shall reside on the Enterprise wide network, which is same high-speed network as the workstations. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP). Local connections of the Building Controller shall be on ISO 8802-3 (Ethernet). Communications shall use Annex J of ASHRAE Standard 135-95. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers. Each Building Controller shall perform communications to a network of Custom Application and Application Specific Controllers using LonTalk FTT-10 and LonMark profiles or BACnet.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage

13. CUSTOM APPLICATION CONTROLLERS

A. General. Provide Custom Application Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the local strategies described in System software section.

2. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. Controllers that perform scheduling shall have a real time clock.

4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

5. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

   a) Assume a predetermined failure mode.
   b) Generate an alarm notification.

6. Custom application controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall be with the use of LonMark-approved SNVTs.

B. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controller used in conditioned ambient shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].

2. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 C to 70 C [-40 F to 158 F].

C. A local operator interface shall be provided at building locations where specified in the sequence of operations or point list. The operator interface shall be provided for interrogating and editing data. A system security password shall be available to prevent unauthorized use of the keypad and display.

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.

E. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

14. APPLICATION SPECIFIC CONTROLLERS

A. General. Application specific controllers (ASC) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

2. Each ASC will contain sufficient I/O capacity to control the target system.

B. Environment. The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 C to 65 C [-40 F to 150 F].

2. Controller used in conditioned ambient shall be mounted in NEMA 1 type rated enclosures. Controllers located where not to be disturbed by building activity (such as above ceiling grid), may be provided with plenum-rated enclosures and non-enclosed wiring connections for plenum cabling. All controllers shall be rated for operation at 0 C to 50 C [32 F to 120 F].

C. Serviceability. Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.

D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.

E. Immunity to Power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

F. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.

G. Application Specific Controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall follow LonMark profiles. ASCs which do not have a profile that applies must comply with LonMark standards, utilize SNVTs for all listed points, and be provided with a XIF file for self-documentation.

15. COMMUNICATIONS

A. This project shall comprise a network utilizing BACnet for communications between Building Controllers and PC Workstations. LonTalk or BACnet subnetworks shall be used for communications between Building Controllers, Custom Application Controllers and Application Specific Controllers.

B. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined earlier in this section.

C. The owner will provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network. A 10BaseT jack will be provided adjacent to each Building Control Panel and PC Workstation for connection to this network.

D. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet. Building controllers shall also have a LonTalk communications port which supports FTT-10.

E. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.

F. The time clocks in all controllers shall be automatically synchronized daily.

16. INPUT/OUTPUT INTERFACE

A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.

B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.

D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.

F. Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom programmable controllers shall have status lights, a 2-position (auto/manual) switch, and manually adjustable potentiometer for manual override.

17. AUXILIARY CONTROL DEVICES

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.

2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.

3. Damper shaft bearings shall be as recommended by manufacturer for application.

4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.

5. All leakage testing and pressure ratings will be based on AMCA Publication 500.

6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

B. Control dampers shall be parallel or opposed blade types as scheduled on drawings.

C. Electronic damper/valve actuators.

1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.

4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.

6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation

8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

9. Actuators shall be Underwriters Laboratories Standard 873 listed.

10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

D. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.

2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

a) Water Valves:
   i. Two-way: 150% of total system (pump) head.
   ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
b) Steam Valves: 150% of operating (inlet) pressure.

3. Water Valves:

a) Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

b) Sizing Criteria:
   i. Two-position service: Line size.
   ii. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or [5] psi, whichever is greater.
   iii. Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), [5] psi maximum.
   iv. Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
   v. 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

c) Water valves shall fail normally open or closed as scheduled on plans or as follows:
   i. Heating coils in air handlers - normally open.
   ii. Chilled water control valves - normally closed.
   iii. Other applications - as scheduled or as required by sequence of operation.

d) Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

E. TEMPERATURE SENSORS

1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.

2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 feet] in length.

3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.

4. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 C [0.2 F].

F. HUMIDITY SENSORS

1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of ±5% R.H.

2. Duct sensors shall be provided with a sampling chamber.

3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% R.H. It shall be suitable for ambient conditions of -40 C to 75 C [-40 F to 170 F].

4. Humidity sensor's drift shall not exceed 1% of full scale per year.

G. STATIC PRESSURE SENSORS

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.

4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

H. LOW LIMIT THERMOSTATS

1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section.

2. Low limit shall be manual reset only.

I. FLOW SWITCHES

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.

2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 Type enclosure unless otherwise specified:

3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.

4. Current sensing relays may be used for flow sensing or terminal devices.

J. RELAYS

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.

2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

K. TRANSFORMERS and POWER SUPPLIES

1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.

3. Unit shall operate between 0 C and 50 C.

4. Unit shall be UL recognized.

L. CURRENT SWITCHES

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

M. LOCAL CONTROL PANELS

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.

2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per

control/interlock drawings, with adequate clearance for field wiring. Control termination's for field connection shall be individually identified per control drawings.

3. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

18. EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

19. GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

20. WIRING

A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ with those in Division 26, the requirements of this section shall take precedence. Also refer to section 4 of this Specification section.

B. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

C. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

D. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.

E. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

F. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.

G. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.

H. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

I. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

J. Adhere to Division 26 requirements for installation of raceway.

K. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

L. Flexible metal conduits and liquidtight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquidtight, flexible metal conduits shall be used.

M. New thermostats, sensors, etc. installed on existing wall shall be installed with concealed wiring. All thermostats are to be flush mounted or full recessed.

21. FIBER OPTIC CABLE SYSTEM

A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fibber bend radii as specified by cable manufacturer shall be maintained.

B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacture's specifications.

C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

22. INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequate for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Install duct static pressure tap with tube end facing directly down-stream of air flow.

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.

H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.

I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

23. FLOW SWITCH INSTALLATION

A. Install using a thread-o-let in steel pipe. In copper pipe use C x C x F Tee, no pipe extensions or substitutions allowed.

B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream or 2 feet whichever is greater, from fittings and other obstructions.

C. Install in accordance with manufacturers' instructions.

D. Assure correct flow direction and alignment.

E. Mount in horizontal piping - flow switch on top of the pipe.

24. ACTUATORS

A. Mount and link control damper actuators per manufacturer's instructions.

B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

D. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

25. WARNING LABELS

A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

C A U T I O N
This equipment is operating under automatic control and may start at any time without warning.

26. IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

27. CONTROLLERS

A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building level Controllers shall be BACnet/IP. Local controllers for equipment may be BACnet/mstp or LON.

C. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of [15%] spare I/O point capacity for each point type found at each location. If input points are not universal, [15%] of each type is required. If outputs are not universal, [15%] of each type is required. A minimum of one spare is required for each type of point used.

D. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

28. PROGRAMMING

A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Software Programming

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. Operators' Interface

1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the building. These standard graphics shall show all points dynamically as specified in the points list.
2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.

E. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

F. Temperature and controls contractor shall include a minimum of 32 hours of time for assisting test and balance contractor with distributive pumps, dedicated outside air, geothermal pumps, heat pumps, etc.

29. CLEANING

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

30. PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

31. FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

32. OPTINET FACILITY MONITORING SYSTEM

A. See drawings.

33. AIR QUALITY MONITORING SYSTEM

a. GENERAL

1. Drawings and general provisions of the Contract, including General Conditions of the Contract, General Conduct of the Work and Special Requirements, and Division 1 Specification Sections, apply to this Section.

b. OVERVIEW

1. This document contains the specification and input/output summaries for a Facility Monitoring System (MS). The system architecture shall utilize local room sensors, duct and outside air probes networked to distributed Air Data Routers and Sensors Suites communicating over a data and air sampling network. The air sampling network shall consist of an air packet transportation network that shall transport air samples from the environment being monitored to distributed Sensor Suites located throughout the facility. The air sampling network shall consist of intelligent air packet routers, an electrically conductive micro duct network, and structured cable. Gathering of air samples shall occur via room, duct mounted, and outside air sampling sensors and probes located as indicated in the documents. The MS shall provide continuous monitoring of environmental conditions as prescribed in the Sensor Suite section, and provide protected access via a web based user interface to analytical summaries in onscreen and report form. The MS shall interface with other

analog and microprocessor based building subsystems as shown on the drawings, specified herein and in other sections.

c. RELATED SECTIONS

1. 3rd-Party Interfacing is required on this project according to the following Specification sections for sub-systems:

a. Section 15900 – Controls

2. REFERENCES

a. ANSI/ASHRAE 135-2001: BACnet™ - A Data Communication Protocol for Building Automation Systems: This shall include the Standard and all published Addenda.

d. DEFINITIONS

1. MS refers to the Facility Management System. (Similar terms are: EMS, Energy Management System; BMS, Building Management System; or ATC, Automatic Temperature Control. BAS Building Automation System.)
2. FMC refers to the Facility Monitoring System Contractor. The FMC is the Contractor responsible for the implementation of this Section of the Specifications.
3. MS refers to the hardware, software and other components comprising the Facility Monitoring System as herein described.
4. I/O refers to Input/Output. Thus, "I/O device" means "Input/Output device".

e. ACCEPTABLE FACILITY MONITORING SYSTEM CONTRACTOR (FMC)

1. The FMC shall have support services within a 120 mile radius of Project Site and comply with the service requirements of a 24 hour response time. Support services is defined as having complete parts inventory, having all required test and diagnostic equipment, and have trained technicians on the systems specified herein. The Facility Monitoring System specified herein, shall be by Aircuity, Inc., Newton Massachusetts. – no other manufacturers are allowed.

f. Contractor Responsibilities:

1. The FMC shall furnish all necessary hardware, wiring, structured cable, tubing, computing equipment and software required to provide a complete and functional system necessary to perform the design intent and as defined in this specification.
2. Installation of all MS components; and all electrical work required as an integral part of this section as noted in Part 5.0 Execution including but not limited to Sensor Suites, Air Data Routers, Room Sensors, Duct Probes, Transformers, Vacuum Pumps, Information Management Servers, Structured Cable, etc., shall be by the MS supplier.
3. The Contractor shall include in their bid price a **five year** service agreement to monitor and maintain the MS. This shall include all replacements of the sensor as

well as any required maintenance or service required for the proper operation of the Sensing Suite, routers, software, etc.

g. System Requirements

1. All material and equipment used shall be standard components, regularly manufactured and available by the manufacturer and not custom designed especially for this project. All systems and components, except site specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.
2. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
3. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

h. Equipment

1. System Hardware

a. The FMC shall provide the following:

1) All Air Data Routers, Sensor Suites, Sensor Suite Sensors, Room Sensors, Duct Probes, Outside Air Probes Information Management Servers, Vacuum Pumps, Structured Cable, transformers, required to perform the functions listed.

2. System Software

a. The FMC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the FMC, including point descriptors, test sequences, reports and point summaries. The FMC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
b. The FMC shall provide a BACnet compatible integration server and software to interface with the facility's BAS.

3. Building Ethernet Connection Cabling:

a. The FMC shall provide CAT-5e or CAT-6 cabling and installation between the Information Management Server and the owner's Building Ethernet Connection. Final Building Ethernet Connection shall be coordinated with the owner's IT Group.

4. Codes and Regulations

a. All electrical equipment and material and its installation shall conform to the current requirements of the following authorities:
1) Occupational Safety and Health Act (OSHA)

2) National Electric Code (NEC)
3) National Fire Code

b. All Air Data Routers and Sensor Suites shall be listed per:
1) Underwriters Laboratories UL916 for Open Energy Management

c. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

5. The control system manufacturer shall have quality control procedures for design and manufacture of facility monitoring systems for precision monitoring, indoor air quality, energy savings and preventative maintenance.
6. The FMC shall provide all test area attribute data and programming and shall coordinate object naming conventions and network map requirements with the owner's internal BAS department. The naming convention shall be submitted with the FMC Shop Drawings for review and approval by owner's BAS department.

i. SUBMITTALS

1. As soon as Submittals are prepared, an electronic version shall be provided simultaneously with the mailing of the paper copies. This version shall be transmitted in electronic format, via e-mail, to expedite the approval process.
2. Shop Drawings shall include:

a. Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
b. Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
c. Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser. Riser shall include room locations and addressing for each Air Data Router and Sensor Suite. Include a Bill of Material for all equipment in this diagram but not included with the unique controlled systems.
d. Device Addressing Scheme: Install controllers implementing an addressing scheme consistent with a reference-document. The addressing scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
e. Equipment Numbering: Equipment numbering scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
f. Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.
g. System Schematic: Drawings shall include a single-line representation of all areas being monitored and/or controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.
h. Point-to-point Wiring Details: Drawings shall include point-to-point wiring details and must show all field devices, routers, sensor suites, controllers, panel devices, wiring terminal numbers and any special information (i.e.

shielding requirements) for properly monitoring areas and controlling equipment.

i. Bill of Material: Drawings shall include a bill of the material necessary and used for properly controlling equipment and implementing the required sequences of operation.
j. Configuration Details: Drawings shall include test and cluster sequence schedules for each test point.
k. As-Built Drawings shall be created after the final system checkout, by modifying and adding to the Shop Drawings. As-Built Drawings shall show exact installation. As-Built Drawings will be acknowledged in writing by the project design engineer and the owner's representative after the final checkout of the system. The system will not be considered complete until the As-Built Drawings have received their final approval. The FMC shall provide four sets of As-Built Drawings.

3. Operating and Maintenance Manuals

a. Operating and Maintenance (O&M) manuals for the system shall include project specific, detailed information describing the specific installation. Manual shall contain as a minimum:

1) System overview
2) Networking architecture
3) Established test sequences and cluster schedules
4) Hardware cut-sheets and product descriptions
5) Wiring diagrams for all controllers and field hardware
6) Installation, mounting and connection details for all field hardware and accessories
7) Commissioning and setup parameters for all field hardware
8) Maintenance procedures, including final tuning and calibration parameters

j. CONTRACTOR (FMC) EXPERIENCE AND PERFORMANCE

1. The FMC shall have a local office or representative, staffed with factory trained engineers, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The FMC shall be responsible for replacement of all products supplied at all times for a period of not less than 1 year following project completion, and shall provide a 24 hour response to a service/warranty call from the owner.

k. WARRANTY

1. Repair or replace any defective product and correct any defect in material or workmanship for a period of 12 months following the date of acceptance of the system.

l. SENSOR PROPOSAL

1. A proposal shall be furnished to the owner at the time of the bid noting all annual service costs for the sensors and sensor elements to be provided within the Sensor Suite; and all costs to insure their ongoing performance. The proposal shall detail all costs for sensor element replacement, calibration services, diagnostics, software upgrades, materials and equipment necessary for ongoing sensor operation. As a minimum, twice a year, provide calibration with NIST approved calibration gases and test instrumentation, functional testing, sensor element evaluation to determine useful life and element replacement as required, and evaluation services to insure the ongoing performance of all sensors as installed system per this specification. This service shall include, but not be limited to the following:

    a. Provide a factory certified depot to remove all sensors within the sensor suite on a periodic basis (as a minimum, twice per year), and replace with pre-packaged, certified, industry traceable, factory calibrated sensors. Removed sensors shall be returned to the FMC for factory recalibration, upgrades, sensor element replacement, and component and board repairs. Written records shall be provided to the owner for every visit indicating the performance of such calibrations along with all pertinent data.
    b. All costs for the repair and replacement of any defective sensor, and for any consumable element or part on the sensor shall be included.
    c. All system software upgrades to correct bugs, fixes and patches for the sensors shall be included.
    d. Note: Refer to Part 6, Sub Section C. Proposal to be included in shop drawings for approval, cost of this shall be included in this contract.

m. AIR DATA ROUTERS

1. The Air Data Router shall be furnished as a complete, self contained, unit housing all electronics, air solenoid valves, sampling manifolds, firmware, and software. Unit shall be furnished with all internal devices and wiring assembled and tested at the factory.
2. Air Data Routers shall receive commands from the Sensor Suite to open the solenoid valve of each test area to be monitored while simultaneously closing all the other solenoid valves in the system. A direct path between the test area and the virtual sensors located with the Sensor Suite shall be established to draw a continuous stream of air through the Structured Cable.
3. Air Data Routers shall consist of an enclosure; terminations areas for both field wiring and Structured Cable connections; a communications/processor board; high capacity solenoid valves; and sampling manifold.
4. Air Data Router shall have provisions to interface to the MS Structured Cable. Air Data Router shall utilize an internal, factory pre-assembled air sampling manifold to interface to the on-board solenoid valves, and push to connect speed fittings for ease of interface to the Structured Cable. Romex connectors and knockouts shall be factory furnished and installed on the Router.
5. Air Data Routers shall be capable of sampling of up to four test areas. Air Data Routers shall be sized and configured with the appropriate number of air sampling solenoid valves including all hardware and software to accommodate the number of test areas noted on the plans and/or specifications.

6. Air Data Router shall have the capacity to sense per test area the temperature at the room, duct or outside air via a room temperature sensor, duct probe, or outside air probe. A total of four sensor inputs shall be provided that corresponds to the air sampling of the respective four test areas.
7. Air Data router shall be capable of accepting universal 0-10v and 4-20mA inputs and outputs through expansion boards for interfacing to other third party devices and controllers.
8. Up to 30 Air Data Routers shall communicate on an isolated RS-485 network with the Sensor Suite.
9. All point data, algorithms and application software within the Air Data Routers shall be programmable from the Information Management Server. Each Air Data Router shall contain both software and firmware to receive and perform full test sequencing schemes downloaded from the Server.
10. Each Air Data Router shall contain a serial port for the interface with a portable computer. Air Data Router and network interrogation shall be possible through this port.
11. Air Data Routers shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
12. Air Data Routers shall have LED indication for visual status of communication and power.
13. Air Data Routers shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite that serves the Air Data Router. Low voltage power shall be distributed to the Air Date Routers through the associated structured cable.

n. SENSOR SUITE

1. The Sensor Suite shall be a distributed, network based, multipoint sensing device. The Sensor Suite shall be furnished as a complete, self contained unit housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.
2. The Sensor Suite shall provide communications between the Air Data Router sub network and the Information Management Server over an isolated RS-485 network. The Sensor Suite shall support communications with a sub network of 30 Air Data Routers; 30 other Sensor Suites, and an Information Management Server.
3. The Sensor Suite base unit shall consist of an enclosure; hinged door with keyed lock; terminations area for both field wiring and Structured Cable connections; a communications/processor board; electronic flow measurement and controller assembly; and sensor bay.
4. The Sensor Suite shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. As a minimum, the Sensor Suite shall be incorporate the following sensors to meet the required applications:

    a. CO2 based Demand Controlled Ventilation (DCV) or Monitoring. CO2 sensor to be Dual wavelength, non-dispersive infrared, range 0-3000 PPM; accuracy +/-75 PPM; repeatability +/- 9 PPM; response time 10 seconds.

5. The Sensor Suite shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration

and service. Additional, modular sensor bay expansion capabilities shall be provided for additional sensors.

6. The Sensor Suite shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Structured Cable.
7. On-board diagnostics shall continuously perform system checks.
8. Each Sensor Suite shall contain a serial port for the interface with a portable computer. Sensor Suite and network interrogation shall be possible through this port.
9. Sensor Suites shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
10. Sensor Suites shall have LED indication for visual status of communication and power.
11. Sensor Suites shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite provided by the FMC. Transformer shall also distribute low voltage power to the Air Date Routers connected to the Sensor Suite through the associated structured cable.

o. INFORMATION MANAGEMENT SERVER

1. The Information Management Server (Server) shall provide network management of Sensor Suites, integration to the BAS, and interface to the web based Aircuity Knowledge Center for viewing and outputting graphs, charts and data derived from the Facility Monitoring System.
2. The hardware platform for the Server shall, at a minimum, consist of:

    a. PC processor with minimum 64-bit word structure.
    b. Minimum 1 GHz processor speed.
    3. Minimum 256MB on board RAM
    4. Hard drive or equal high-speed data storage, minimum 20 gigabytes.
    5. Network Interface Card: (10/100)
    6. RS-232 Serial Port
    7. Operating System shall be Windows.

3. The Contractor shall provide CAT-5e or CAT-6 cabling and installation between the Information Management Server's Network Interface Card and the owner's Building Ethernet Connection.
4. The Server shall be located within 25 feet of the nearest Sensor Suite and be connected to the Server through the RS-232 serial port.

p. OT TUBING (CO2/CO Applications only)

1. The FMS shall utilize a pre-engineered system of OT Tubing to provide a low cost sampling conduit for air samples when the only contaminants of concern are either carbon dioxide (CO2) or carbon monoxide (CO).
2. OT Tubing shall be 3/8" O.D. (1/4" I.D.), dimensionally stable and shall conform to NFPA 90A flame and smoke spread indices for return air plenum installations.

3. OT Tubing shall not require any specialized tools for installation. Installation of the Tubing shall follow traditional local area network practices.
4. OT Tubing shall carry incremental length markings (in feet) throughout the Tubing length.
5. OT Tubing shall require the use of enlarger fittings (catalog number OT-E11) for all OT Tubing connections made to ADRs and duct probes. Enlarger fittings shall not be required for connecting OT Tubing to Room Sensors.
6. The minimum length of Tubing run between an ADR test area connection and an end device shall be no shorter than 20 feet.

q. ROOM SENSORS/DUCT PROBES

1. Room Sensors:
    a. A semi-flush mounted, wall plate with an integral air sampling port is to be provided; the port within the enclosure will accept the MicroDuct from the Structured Cable.
    b. Internal coarse filter to screen out large particulate from entering the MicroDuct.
    c. Terminations:
        1) Sensor – one wire
        2) Power – three wire
        3) MicroDuct – integral hose clamp
    d. Provide option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.

2. Outdoor Air Mount

    a. A duct temperature sensor and air sample probe is to be mounted within one enclosure. Probe to accept integral MicroDuct from Structured Cable.
    b. Internal coarse filter to screen out large particulate from entering the MicroDuct.
    c. Terminations:
        1) Sensor – one wire
        2) Power – three wire
        3) MicroDuct – speed fitting
    d. Provide option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.
    e. Outdoor Air Locations – A NEMA 4X weatherproof enclosure shall be provided.

r. SYSTEM SOFTWARE OVERVIEW

1. The FMC shall provide all software required for operation of the MS system specified herein. All functionality described herein shall be regarded as a minimum. The FMC shall provide the following as a minimum:

    a. Completed database.
    b. Configuration of all Air Data Router, Sensor Suite, Server and user interface application programs.

c. All Configuration Tools, and all software licenses, required to configure and operate all products installed on this project.

s. SYSTEM CONFIGURATION

1. Database Creation and Modification. All changes shall be done utilizing standard procedures. The system shall allow changes to be made either at the local site through the Information Management Server.
2. The system shall permit the operator to perform, as a minimum, the following:
   a. Add and delete points/objects
   b. Modify point parameters
   c. Create and modify control sequences and programs
   d. Reconfigure application programs

t. WEB BASED USER INTERFACE AND DATA MANAGEMENT SYSTEM

1. Included with the system shall be a fully integrated web based user interface and data management system. The data management system shall be password protected and shall be able to store sampled data from all test areas for online viewing and reporting.
2. Unlimited data access, viewing, report generation and remote data storage shall be provided with the MS for the duration of the project commissioning and for the entire warranty period.

u. TEST SEQUENCING

1. The system shall allow the operator to designate any test area to be scheduled with an operator command through the Information Management Server.
2. The operator shall be able to make all schedule additions, modifications and deletions to the test schedules. The operator shall have the capability to edit all schedules and then download any or all schedule changes to the MS.

v. EXECUTION

1. Verify that systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the MS.
2. Install software in Air Data Routers, Sensor Suites and Server. Implement all features of programs to specified requirements and as appropriate for sequence of operation.
3. Connect and configure equipment and software to achieve sequence of operation specified.

w. WIRING INSTALLATION

1. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use

electrical products complying with requirements of applicable Division 26 sections of these specifications.

2. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 26 section and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).
3. Provide wiring as required by functions as specified and as recommended by equipment manufacturer to serve specified control functions.
4. Install wiring and cables according to Division 26 section and as follows:

    a. Bundle and harness multi-conductor cable in place of single cables where several cables follow a common path.
    b. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

5. All exposed control wiring and control wiring in the mechanical, electrical, telephone, and similar rooms shall be installed in raceways. All other wiring shall be installed neatly and inconspicuously.
6. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Wiring buried in slab-on-grade concrete or explosion-proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

x. CONTROL DEVICE INSTALLATION

1. All room sensors and shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings.

a. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.

b. Enclosures and panels mounted directly to the wall shall be provided with a minimum airspace of 1" between the enclosure and the wall.

c. A minimum of 3' working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.

d. Mounting height shall be a maximum 6'-6" to the top of the enclosure.

e. A field-installed, 14-gage galvanized steel drip shield shall be provided where enclosures and panels may be subjected to dripping water.

PART 25 - CONTROL POWER

a. Provide power for Air Data Routers, Sensor Suites, Server and associated MS components from nearest electrical control panel noted below or as indicated on the electrical drawings—coordinate with Electrical Contractor.

1. Power supply for Air Data Routers, Sensor Suites, Server and associated MS components shall be connected via a dedicated circuit to the building normal electrical distribution panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system. The temperature controls contractor is responsible for this electrical connection.

PART 26 - IDENTIFICATION

a. The FMC shall label each system device with a point address or other clearly identifiable notation inside the device cover - labels shall be permanent. All MS equipment shall be clearly identified as noted on the approved submittals.

PART 27 - ACCEPTANCE OF COMPLETED MS INSTALLATION

a. Upon completion of the installation, the FMC shall start up the system and perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed by the FMC in the presence of the design engineer, job site project manager, and owner’s representative. Acceptance test shall be scheduled with at least 10 working days advance notice. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.

b. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

c. Demonstrate compliance with specifications, including calibration and testing, and air sampling test sequences. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

d. The acceptance test shall include, but not be limited to:

1. The FMC shall verify the proper operation of all input/outputs.
2. The FMC shall verify all inputs meet or exceed manufacturer’s stated tolerances for accuracy.
3. The FMC shall verify that all on-line graphical displays of air sampling test data accurately represent the real time state of the field conditions.
4. The FMC shall verify the reliability of all communications of all Air Data Routers and Sensor Suites.

5. The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.

e. Acceptance: When the field test procedures have been successfully demonstrated to the design engineer, job site project manager, or owner's representative and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by the owner's representative and the warranty period shall start.

PART 28 - TRAINING

a. The FMC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.

b. Training shall include a minimum of one 8 hour session at substantial completion and another 8 hour session to be scheduled during the first year of building occupancy.

c. Instructions shall include 2 parts, the "New Equipment Orientation" and the "Product Training".

d. New Equipment Orientation: A "walk-through" session shall include showing where all field equipment is located throughout the area involved in the project.

e. Product Training: Train technical services and maintenance personnel on-site to adjust, operate, and maintain the MS. As a minimum:

1. Train personnel on procedures and schedules for starting and stopping test sequences, troubleshooting, servicing, and maintaining equipment.

2. Provide operator training on modification of data display, test area descriptors, executing commands, resetting default values, and requesting reports.

END OF SECTION

SECTION 26 05 01 - GENERAL PROVISIONS – ELECTRICAL
APPLIES TO 26 05 02, 26 05 03, 26 05 04, 26 05 08, 26 51 13, 26 51 16, 26 51 22, 26 55 61

1. GENERAL

A. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating electrical systems indicated on the drawings and/or specified herein.

B. It is the intent of this Contract to deliver to the Owner a "new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

C. The Contractor shall provide interim life safety and fire detection measures as required by the Authority Having Jurisdiction, Division 1 specifications, NFPA, and applicable Codes. This includes temporary relocations of heat/smoke detection, exit signage, and egress lighting in existing buildings as applicable.

D. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without request for extra compensation to the Owner, except where otherwise provided for in the contract document.

E. Definitions:

(1) Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.

(2) Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

Note: Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

(3) Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

(4) Engineer - The Consulting Mechanical-Electrical Engineers, either consulting to the Owner, Architect, other Engineers, etc.

(5) Architect - The Architect of Record for the project, if any.

(6) Furnish - Deliver to the site in good condition.

(7) Provide - Furnish and install in complete working order.

(8) Install - Install equipment furnished by others in complete working order.

(9) Contract Documents - All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to: Plans, Specifications, Addenda, Instructions to Bidders, (both General and Sub-Contractors), Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Construction Manager's Assignments, Architect's Supplemental Instructions, Periodical Payment Requests, etc.

2. INTENT

A. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

3. ELECTRICAL DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for review before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly. Refer to Division 01 for coordination drawing requirements.

B. The Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

C. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.

D. The Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

E. Special Note: Always check ceiling heights indicated on Drawings and Schedules and insure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.

F. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

G. The drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

H. The Contractor and his Sub Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.

I. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

4. EXAMINATION OF SITE AND CONDITIONS

A. The Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors or suppliers shall carefully examine all Drawings and Specifications and contract documents to determine the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.

B. The Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. The Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer prior to bid – REFER TO DIVISION 1, any apparent omissions or discrepancies in

order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility

B. References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of paragraph (A) immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten days prior to bid date for approval to bid in written form thru addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.

D. The Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

E. The Contractor shall review the contract documents and if a material substitution form is required for each proposed substitution, it shall be submitted per requirements.

6. CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.

D. All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.

E. All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.

F. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.

G. The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

7. CORRECTION PERIOD

A. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

8. INSPECTION, APPROVALS AND TESTS

A. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

B. The Contractor shall provide as part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services in the Maryland / Baltimore City. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

C. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

D. Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

E. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

F. Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

G. The Contractor shall test all wiring and connections for cross connects, continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by continuity/load/voltage test and Megger Test the installation of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, replacing same with new and demonstrate by further test the elimination of such defect. The secondary service entrance conductors from the utility (source) transformer to the main service disconnecting means shall be megger tested. The results of this test shall be turned over to the engineer for review and approval. Any conductor failing the test shall be replaced and any costs associated shall be borne by the contractor.

9. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

10. CHANGES IN ELECTRICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

11. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

12. SURVEYS, MEASUREMENTS AND GRADES

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

13. TEMPORARY USE OF EQUIPMENT

A. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.

B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

C. Refer to Division 01 for additional requirements.

14. TEMPORARY SERVICES

A. The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

B. Refer to Division 01 for additional requirements.

15. RECORD DRAWINGS

A. Refer to Division 01 for all requirements.

16. MATERIALS AND WORKMANSHIP

A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

B. All conduit and/or conductors shall be concealed in or below walls, floors or above ceilings unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.

C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.

D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the makers mark or name.

E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

17. QUALIFICATIONS OF WORKMEN

A. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for

relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

B. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

C. Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

18. CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

B. Refer to Division 01 for additional requirements.

19. COOPERATION AND COORDINATION BETWEEN TRADES

A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be effected.

B. Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements.

C. Refer to Division 01 for additional requirements.

20. PROTECTION OF EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the manufacturer. All rough-in conduit shall be properly plugged or capped during construction. Equipment damaged while stored on site either before or after installation shall be repaired or replaced by the responsible Contractor.

21. CONCRETE WORK

A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

B. Refer to Structural specifications additional concrete requirements.

Special Note: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

22. SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

23. QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

24. FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturers representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

25. WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

26. ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.

D. Access Doors; in Ceilings or Walls:

(1) In mechanical, electrical, or service spaces:

14 gauge aluminum brushed satin finish, 1" border.

(2) In finished areas:

14 gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.

(3) In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

27. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also refer to Divisions 11, 14, 20, 21, 22, 23 and 25 of the Specifications, shop drawings and equipment schedules for additional information.

B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 and 27 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

C. Each Contractor or sub-contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

28. CUTTING AND PATCHING

A. Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

29. ANCHORS

A. Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

30. WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

31. OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Refer to Division 01 for all operations and manual requirements.

C. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

D. Formatting & content shall follow the guidelines outlined in the latest version of ASHRAE Applications Handbook, Guideline 4. As a minimum, the following shall be included:

- The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
- Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- The operating manual should contain the following information:

I. General Information
   a. Building function
   b. Building description
   c. Operating standards and logs

II. Technical Information
   a. System description
   b. Operating routines and procedures
   c. Seasonal start-up and shutdown
   d. Special procedures
   e. Basic troubleshooting

- The maintenance manual should contain the following information:
   I. Equipment data sheets
      a. Operating and nameplate data
      b. Warranty

   II. Maintenance program information
      a. Manufacturer's installation, operation, and maintenance instructions
      b. Spare parts information
      c. Preventive maintenance actions
      d. Schedule of actions
      e. Action description
      f. History
- Test reports document observed performance during start-up and commissioning.

32. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

33. CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all

associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

34. PAINTING

A. Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

35. HAZARDOUS MATERIALS

A. Refer to Division 00 for Hazardous Materials requirements.

36. ABOVE-CEILING AND FINAL PUNCH LISTS

A. Refer to Division 01 for additional information.

SECTION 26 05 02 - SCOPE OF THE ELECTRICAL WORK

1. GENERAL

Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

2. SCOPE OF THE ELECTRICAL WORK

The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

A. All light fixtures and circuits

B. Paying all necessary fees and cost for permits, inspections, work by utility companies(power).

C. Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid.

D. Photovoltaic system.

E. Low Voltage Lighting system.

END OF SECTION

SECTION 26 05 03 - SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

1. SHOP DRAWINGS

A. If the Contractor fails to comply with the requirements set forth, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

B. Refer to Division 01 for shop drawing requirements.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

Photovoltaic System

- Racking
- Panels
- Inverters
- Software

Lighting

- Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
- LED, each by type.
- Driver each by type.
- Lighting standards or poles.
- Photocells, time clocks or other lighting accessories.
- Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

2. SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

3. MAINTENANCE AND OPERATION MANUALS

A. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. Refer to Division 1 for manual requirements Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:

- The **operation and maintenance document directory** should provide easy access and be well organized and clearly identified.
- **Emergency information** should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- **The operating manual** should contain the following information:
  I. General Information
     a. Building function
     b. Building description
     c. Operating standards and logs

  II. Technical Information
     a. System description
     b. Operating routines and procedures
     c. Seasonal start-up and shutdown
     d. Special procedures
     e. Basic troubleshooting

- **The maintenance manual** should contain the following information:
  I. Equipment data sheets

a. Operating and nameplate data
b. Warranty

II. Maintenance program information
a. Manufacturer's installation, operation, and maintenance instructions
b. Spare parts information
c. Preventive maintenance actions
d. Schedule of actions
e. Action description
f. History

- **Test reports** document observed performance during start-up and commissioning.

END OF SECTION

SECTION 26 05 03 - SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

1. SHOP DRAWINGS

A. If the Contractor fails to comply with the requirements set forth, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

B. Refer to Division 01 for shop drawing requirements.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

Photovoltaic System

- Racking
- Panels
- Inverters
- Software

Lighting

- Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
- LED, each by type.
- Driver each by type.
- Lighting standards or poles.
- Photocells, time clocks or other lighting accessories.
- Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

2. SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

3. MAINTENANCE AND OPERATION MANUALS

A. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. Refer to Division 1 for manual requirements Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:

- The **operation and maintenance document directory** should provide easy access and be well organized and clearly identified.
- **Emergency information** should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- **The operating manual** should contain the following information:
  I. General Information
     a. Building function
     b. Building description
     c. Operating standards and logs

  II. Technical Information
     a. System description
     b. Operating routines and procedures
     c. Seasonal start-up and shutdown
     d. Special procedures
     e. Basic troubleshooting

- **The maintenance manual** should contain the following information:
  I. Equipment data sheets

a. Operating and nameplate data
b. Warranty

II. Maintenance program information
a. Manufacturer's installation, operation, and maintenance instructions
b. Spare parts information
c. Preventive maintenance actions
d. Schedule of actions
e. Action description
f. History

- **Test reports** document observed performance during start-up and commissioning.

END OF SECTION

SECTION 26 05 04 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

   A. Each Contractor's attention is directed to Section 260501, General Provisions, Electrical and all other contract documents as they may apply to his work.

   B. Each Contractor shall include all excavating, filling, grading and related items required to complete his work as shown on the drawings and specified herein.

   C. Depths of bury shall be as indicated on the drawings.

2. SUBSURFACE DATA

   A. Subsurface investigations have been made and the results shown on the drawings. The information was obtained primarily for use in preparing foundation design. Each Contractor may draw his own conclusions therefrom. No responsibility is assumed by the Owner for subsoil quality or conditions other than at the locations and at the time investigations were made. No claim for extra compensation, or for extension of time, will be allowed on account of subsurface conditions inconsistent with the data shown.

   B. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavation to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating.

3. BENCH MARKS AND MONUMENTS

   A. Maintain carefully all bench marks, monuments and other referenced points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

   A. Each Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation for his work.

   B. Excavate trenches to sufficient width and depth for proper installation of the work and where required, smooth the bottom on the trench with hand tools.

   C. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Architect. Any damage to existing structures, exterior services or rock intended for bearing, shall be corrected at the responsible Contractor's expense.

   D. Keep trenches free from water while construction therein is in progress. Under no circumstances lay conduit or cable in water. Pumping or bailing water from this Contractor's trenches, which is required during construction shall be accomplished at his expense.

E. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, etc. Each Contractor shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage, or any other damage incurred in the course of excavation, shall be borne by the responsible Contractor.

5. BACKFILL

A. Backfill shall be accomplished with clean debris free earth and the new earth tamped at 12" intervals so as to avoid earth sinks along the trench. The responsible Contractor will be required to return to the project and fill any sunken areas along the route of his work.

B. Backfill trenches only after conduit and cable have been inspected, tested, and locations of pipe lines have been recorded on "as-built" drawings.

C. The backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.

D. The backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

END OF SECTION

SECTION 26 05 08 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

   A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing, Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

   B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

   C. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

   D. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Architect and Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Architect or Engineer where in doubt about the potential acceptability of an installation.

2. INTERFACING

   Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall insure that coordination is effected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

   A. Coordination of PV system to utility company.

   B. Electrical power connections to electrically operated (or controlled) equipment.

   C. Electrical provisions for all equipment provided by other trades or suppliers within this contract.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden Inc.
   2. Encore Wire Corporation.
   3. General Cable Technologies Corporation.
   4. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Power Systems, Inc.
   2. Ilsco; a branch of Bardes Corporation.
   3. O-Z/Gedney; a brand of the EGS Electrical Group.
   4. 3M; Electrical Markets Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

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

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in racewayor Metal-clad cable, Type MC as allowed by NEC and Building Owner.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to requirements in other sections prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to requirements in other sections.

G. Complete cable tray systems installation according to requirements in other sections prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to requirements in other sections.

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in other sections.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to requirements in other sections.

3.8 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

      a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test and Inspection Reports: Prepare a written report to record the following:
   1. Procedures used.
   2. Results that comply with requirements.

3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. Multimode optical-fiber cabling.
   2. UTP cabling.
   3. RS-485 cabling.
   4. Low-voltage control cabling.
   5. Control-circuit conductors.
   6. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

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.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
   1. Flame Travel Distance: 60 inches (1520 mm) or less.
   2. Peak Optical Smoke Density: 0.5 or less.
   3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in other sections.

B. Painting: Paint plywood on all sides and edges with flat white latex paint. Comply with requirements in other sections.

2.4 OPTICAL-FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden Inc.
   2. Corning Incorporated.
   3. Nexans; Berk-Tek Products.
   4. 3M.
   5. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive, tight-buffer, optical-fiber cable.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with TIA-492AAAA-B for detailed specifications.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
      b. Riser Rated, Nonconductive: Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
      c. General Purpose, Nonconductive: Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
      d. Plenum Rated, Conductive: Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
      e. Riser Rated, Conductive: Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit.
      f. General Purpose, Conductive: Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit.

5. Conductive cable shall be steel-armored type.
6. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:
1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.5 OPTICAL-FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden Inc.
2. Corning Incorporated.
3. Hubbell Incorporated.
4. Panduit Corp.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.

D. Cable Connecting Hardware:
1. Comply with Optical-Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA-568-C.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss of not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.6 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden Inc.
2. Superior Essex Inc.
3. SYSTIMAX Solutions; a CommScope, Inc. brand.
4. 3M.
5. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, four-pair UTP, 24-pair UTP, formed into four-pair binder groups with no overall jacket.
1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.
2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.
3. Comply with TIA-568-C.1 for performance specifications.
4. Comply with TIA-568-C.2, Category 5e.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444and NFPA 70 for the following types:
a. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

b. Communications, Riser Rated: Type CMP or Type CMR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
c. Communications, General Purpose: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.7 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden Inc.
2. Hubbell Incorporated.
3. Leviton Commercial Networks Division.
4. Panduit Corp.
5. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair.

E. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

F. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; terminated with eight-position modular plug at each end.
1. Patch cords shall have color-coded boots for circuit identification.

G. Workstation Outlets: Two-port-connector assemblies mounted in single faceplate.

H. Faceplates:
1. Plastic Faceplate: High-impact plastic. Coordinate color with requirements in other sections.
2. Metal Faceplate: complying with requirements in Other sections.
3. For use with snap-in jacks accommodating any combination of UTP, optical-fiber, and coaxial work area cords.
a. Flush-mounted jacks, positioning the cord at a 45-degree angle.

I. Legend:
1. Factory labeled by silk-screening or engraving forstainless steelfaceplates.

2.8 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.
1. Paired, two pairs, No. 20 AWG, stranded **(**7x28) tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

6. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, two pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.9 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.
1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.10 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.
1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Encore Wire Corporation.
2. General Cable Technologies Corporation.
3. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.

C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
   1. Smoke control signaling and control circuits.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables according to TIA-568-C.2.

C. Factory test optical-fiber cables according to TIA-568-C.3.

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

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.
   1. Test optical-fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set.
   2. Test optical-fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in other sections for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
   2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 1-1/2 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.
   4. Extend conduits 3 inches above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:
   1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
   2. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   3. Cables may not be spliced.
   4. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
   6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
   8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
   9. Support: Do not allow cables to lay on removable ceiling tiles.
   10. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:
   1. Comply with TIA-568-C.2.
   2. Install termination hardware as specified in other sections unless otherwise indicated.
   3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:
   1. Install wiring in raceways. Comply with requirements specified in other sections.

E. Optical-Fiber Cable Installation:
   1. Comply with TIA-568-C.3.
   2. Terminate cable on connecting hardware that is rack or cabinet mounted.

F. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
   3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits; No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.5 FIRESTOPPING

A. Comply with requirements in other sections.

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.6 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in other sections.

3.7 IDENTIFICATION

A. Comply with requirements for identification specified in other sections.

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.8 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   4. Optical-Fiber Cable Tests:
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Link End-to-End Attenuation Tests:
         1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
         2) Attenuation test results for links shall be less than 2.0 dB.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding systems and equipment, plus the following special applications:
   1. Ground bonding common with lightning protection system.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.
   5. Grounding for sensitive electronic equipment.

B. Qualification Data: For qualified testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections include the following:
   1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
      a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      b. Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches or as indicated on the contract drawings in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel**,** sectional type; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
   8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
   9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
   1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
   3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12 inches deep, with cover.
   1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches from building's foundation.

J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.4 LABELING

A. Comply with requirements in other sections for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer.
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal**,** at ground test wells. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

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

E. Prepare test and inspection reports.

F. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 > ohms.

G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

B. Related Sections include the following:
   1. Refer to International Building Code (IBC) for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in other sections.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. ERICO International Corporation.
      c. Thomas & Betts Corporation.
      d. Unistrut; Tyco International, Ltd.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Channel Dimensions: Selected for applicable load criteria.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.
5. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
6. Fitting and Accessory Materials: Same as channels and angles.
7. Rated Strength: Selected to suit applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in other sections for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in other sections for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in other sections.

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

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

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

END OF SECTION

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Surface raceways.
   4. Boxes, enclosures, and cabinets.
   5. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Samples: For wireways and surface raceways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. O-Z/Gedney; a brand of EGS Electrical Group.
   3. Thomas & Betts Corporation.
   4. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: compression.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, or GRC, : Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman; a Pentair company.
   3. Mono-Systems, Inc.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mono-Systems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems Division.
      b. Mono-Systems, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Technologies Company; Cooper Crouse-Hinds.
   2. FSR Inc.
   3. Hoffman; a Pentair company.
   4. O-Z/Gedney; a brand of EGS Electrical Group.
   5. RACO; a Hubbell Company.
   6. Spring City Electrical Manufacturing Company.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:
   1. Material: Cast metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.

4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round].
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

N. Gangable boxes are allowed.

O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation; Hubbell Power Systems.
   d. Oldcastle Precast, Inc.; Christy Concrete Products.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after

installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in other sections.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inchesof enclosures to which attached.

I. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-footintervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:
   1. Install surface raceway with a minimum 2-inchradius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
      d. Attics: 135 deg F temperature change.
   3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Locate boxes so that cover or plate will not span different building finishes.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in other sections.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in other sections.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
6. Underground Warning Tape: Comply with requirements in other sections.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, 36 inches below grade.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in other sections.

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in other sections.

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
1. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
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 corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Presealed Systems.

2.4 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in other sections.
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 CUTTING AND PATCHING

A. The contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe or any other work in insulated concrete form (ICF) wall, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the Mechanical and Electrical work is complete. Furthermore all new work shall not be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Colors for Cables Carrying Circuits at 600 V and Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage.

C. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

C. Tag:
1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft..
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

C. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face..
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

B. Stenciled Legend: In nonfading, waterproof, black > ink or paint. Minimum letter height shall be 1 inch.

2.10 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

F. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH

VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Emergency Power.
   2. Power.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
      a. Color shall be factory applied.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. Colors for 480/277-V Circuits:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.

F. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.

G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer >.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchgear.
      e. Switchboards.
      f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      g. Emergency system boxes and enclosures.
      h. Enclosed switches.
      i. Enclosed circuit breakers.
      j. Enclosed controllers.

k. Variable-speed controllers.
l. Push-button stations.
m. Power transfer equipment.
n. Contactors.
o. Remote-controlled switches, dimmer modules, and control devices.

END OF SECTION

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device coordination and arc flash hazard Analysis studies. Protective devices shall be set based on results of the protective device coordination study.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Arc Flash Hazard Analysis Study Report.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study, fault-current-study and arc flash hazard analysis study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 and IEEE 1584 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
   1. EDSA Micro Corporation.
   2. ESA Inc.
   3. Operation Technology, Inc.
   4. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
   1. Optional Features:
      a. Arcing faults.
      b. Simultaneous faults.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchgear and switchboard bus.
   2. Distribution panelboard.
   3. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
   1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   2. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.
2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arch flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, panelboards, busway, motor control centers and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 208 volt systems fed from transformers equal or greater than 125 KVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/sq. cm.

E. When appropriate, the short-circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume a minimum motor contribution (all motor off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy overtime when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible.

H. For each equipment location with a separely enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Incident energy and flash protection boundary calculations shall include:
   1. Arcing fault magnitude
   2. Protective device clearing time
   3. Duration of arc
   4. Arc flash boundary
   5. Working distance
   6. Incident energy
   7. Hazard Risk Category
   8. Recommendations for arc flash energy reduction

3.6 ARC FLASH WARNING LABELS

A. The contractor of the arc flash hazard analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:
   1. Location designation
   2. Nominal voltage
   3. Flash protection boundary
   4. Hazard risk category
   5. Incident energy
   6. Working distance
   7. Engineering report number, revision number and issue date.

D. Labels shall be machined printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
   1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
   2. For each motor control center, one arc flash label shall be provided.
   3. For each low voltage switchboard, one arc flash label shall be provided.

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the startup and acceptance testing contract portion.

END OF SECTION

SECTION 23 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

1. GENERAL

   A. RELATED WORK

      1. Division 22 – Plumbing

      2. Division 23 - Mechanical

   B. REFERENCES

      1. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

      2. ASHRAE Guideline 1-1996

      3. ASHRAE Guideline 0-2005

      4. ACG Commissioning Guideline – 2005

   B. DESCRIPTION OF WORK

      1. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the electrical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

      2. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

2. PRODUCTS

   A. Not used.

3. EXECUTION

A. ROLES OF THE COMMISSIONING AGENCY

1. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of Electrical systems within the facility.

2. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

3. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

4. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

5. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

6. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

7. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

8. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for Electrical systems and subsystems.

9. The CA will review operating and maintenance materials for Electrical systems.

10. The CA will review phasing plans as provided by the CM relating to temporary use of Electrical equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

B. SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

1. Main Normal Distribution
2. Emergency Power Systems
3. Lighting Control Systems
4. PV Systems
5. Energy Metering System
6. Energy Dashboard

C. ELECTRICAL COMMISSIONING PLAN

1. Commissioning Team

a. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

Program Manager (PrM)
Facilities Management Division (FMD)
Commissioning Agent (CA)
Design Team (DT)
Construction Manager (CM)
Mechanical Contractor (MC)
Controls Contractor (CC)
Test and Balance Contractor (TABC)
Electrical Contractor (EC)

2. Basis of Design Document

a. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
b. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

3. Commissioning Meetings

a. Commissioning meetings will be held in conjunction with progress meetings as necessary. The CA will be on site for the CX meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

4. Resolution Tracking Forms (RTF)

a. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
b. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

5. System Verification Checklists (SVC) / Manufacturers' Checklists

a. The EC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS*. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
b. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
c. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

6. Start-Up

a. Start-up of major Electrical systems will be witnessed the CA. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Electrical equipment.

b. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

7. Functional Performance Tests (FPT)

a. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS* above.
b. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
c. The Functional Performance Tests shall include Electrical, Lighting, PV and related equipment.

1. The Electrical trade representative will demonstrate to the CxA: main power disconnect switch and feeder disconnect switches over current ground fault sensor trip settings by the primary injection method and in accordance with NETA-ATS Section 7.6, switchboard assemblies megger tested in accordance with NETA-ATS Section 7, switchboard metering instrumentation tests in accordance with NETA-ATS Sections 7.10 and 7.11, and switchboard single phase monitor tests for operation upon loss of a phase.

2. The Electrical trade representative, with the CxA present, will field test for power operation for the emergency generator and transfer switches.

3. Lighting controls will be tested under relevant operating conditions.

4. A remote connection to energy metering system, energy dashboard, PV system, or any other system should be provided to the CA prior to system start-up for use as a tool to determine completion and accuracy of systems. CA in conjunction with the CT will ensure that all systems function properly through FPT's and through trend verification of systems.

d. Deferred Testing

1. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
2. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

e. Rescheduled Functional Performance Test

1. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, contractor shall reimburse the owner for all additional cost the owner incurs as a result of the contractor's failure to be complete and/or to provide operating compliant systems for commissioning. Additional costs include but are not limited to additional fees charged by the architect, engineer, construction manager and commissioning agent.
2. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed for the commissioning personnel's return trip.

8. Building Turn-Over / Owner Orientation / User Training

a. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
b. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
c. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going ELECTRICAL related problems are being addressed and corrected in a timely and efficient manner.
d. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

D. RESPONSIBILITIES OF TEAM MEMBERS

1. Construction Manager (CM)

A. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Electrical commissioning process.
B. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
C. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
D. Coordinate inclusion of commissioning activities in the construction schedule.
E. Facilitate resolution of deficiencies identified by observation or performance testing.
F. Involve CA in selection of the air balancing contractor.
G. Assist the CA in monitoring the duct leakage testing.

2. Electrical Contractor (EC)

A. Include cost for commissioning requirements in the contract price.
B. Review design for provision of power to the Electrical equipment.
C. Attend commissioning meetings scheduled by the CA.
D. Verify proper installation and performance of all Electrical services provided.
E. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of equipment.
F. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
G. Provide an Electrical system technician to assist during verification and performance testing.
H. Participate in the Functional Performance Tests as required to achieve design intent.
I. Participate in the off-season mode testing as required to achieve design intent.
J. Participate in O&M Training as required by project specifications.

END OF SECTION

SECTION 26 09 13 - ELECTRICAL POWER MONITORING AND CONTROL

1.1 SUMMARY

A. Monitoring and control of electrical power circuits through PC-based workstation(s) and software.

1.2 SOFTWARE SERVICE AGREEMENT

A. Technical support for two years.

B. Upgrade service for two years.

1.3 FUNCTIONAL DESCRIPTION

A. Monitor and record load profiles and chart energy consumption patterns for electricity, domestic water, and natural gas.

B. Calculate allocation of utility costs.

C. Identify power system anomalies and measure, display, and record trends and alarms.

D. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources.

E. Manage demand.

F. Report equipment status and power system control.

G. Operating System:
   1. Software: Configured to run on a portable laptop computer, a single PC, or a palm computer.
   2. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously.
   3. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously.
   4. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously; includes interactive graphics client; Web enabled.
   5. Operating System: Based on 32-bit, Microsoft Windows workstation operating system.
   6. Peer computer control software to detect failure of workstation and associated server.

H. Applications Software:
   1. Password protected to three levels.
   2. Automatic and encrypted backups for database and history; automatically stored on central control PC.
   3. Operator audit trail.
   4. Workstation server functions to support other client PCs on the LAN.
   5. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications.
   6. Metered values displayed in real time.
   7. Remote control display of circuit-breaker status and control; and user-defined schemes for load shedding automatically initiated and executed.
   8. Interactive color-graphics platform.
   9. User-defined monitoring, and event control.
   10. Trending reports.
   11. Alarm messages displayed and recorded.
   12. Waveform data displayed and recorded.
   13. Data sharing to third-party applications software.
   14. Tenant or activity billing software.

15. Current alarm, supervisory, and trouble conditions reporting.

1.4 COMPONENTS

A. Power Monitors:
   1. Environmental Conditions:
      a. Indoor installation in non-temperature-controlled spaces.
      b. Ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, non-condensing.
   2. rms real-time measurements.
   3. Demand current calculations, per phase, three-phase average and neutral.
   4. Demand real power calculations, three-phase total.
   5. Demand reactive power calculations, three-phase total.
   6. Demand apparent power calculations, three-phase total.
   7. Average power factor calculations, demand coincident, three-phase total.
   8. Power analysis values.
   9. Power demand calculations.
   10. Current and voltage sampling.
   11. Monthly minimum and maximum values recording.
   12. Harmonic calculations display and recording.
   13. Current and voltage ratings.
   14. Waveform capture.
   15. One digital input signal(s).
   16. Onboard data logging.
   17. Alarms.
   18. Power monitoring communications permanently connected toModbus TCP via a 100 Base-T Ethernet.
   19. Backlighted LCD display monitors with touch-screen selecting devices.

B. Standalone, Web-Enabled Monitoring and Control Instrument:
   1. LAN connectivity: 100 Base-TLAN.
   2. Factory-addressed and -tested communication devices within equipment.
   3. Server configurations for initial network parameters set using Web browser; factory-programmed network server with embedded HTML-formatted Web pages, password-protected login, and firewall-protected operating software.
   4. Network accessible data.
   5. Power monitoring communications permanently connected Modbus TCP via a 100 Base-T Ethernet and local RS-232 access point.

C. Workstation Hardware: Standard unmodified PC.

D. RS-232 ASCII interface with pager and alarm system interface.

E. LAN Cables:
   1. RS-485 cable.
   2. Unshielded twisted pair cable: Category 6.

1.5 CABLING

A. Wiring Method: In raceways except in accessible ceiling spaces or gypsum board partitions.

1.6 FIELD QUALITY CONTROL

A. Testing: By Contractor-engaged agency.

END OF SECTION

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

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.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in the International Building Code. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Qualification Data: For testing agency.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in the International Building Code.

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Taps for Transformers Smaller Than 3 kVA: None.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.

K. Wall Brackets: Manufacturer's standard brackets.

L. Fungus Proofing: Permanent fungicidal treatment for coil and core.

M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in other sections.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in other sections have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in the International Building Code.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions**,** seismic codes applicable to Project, and requirements in other sections.

3.3 CONNECTIONS

A. Ground equipment according to requirements in other sections.

B. Connect wiring according to requirements in other sections.

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 13 - SWITCHBOARDS

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. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include diagram and details of proposed mimic bus.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in the International Building Code. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for switchboards and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NECA 400.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

C. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in the International Building Code.

D. Indoor Enclosures: Steel, NEMA 250, Type 1.

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Barriers: Between adjacent switchboard sections.

G. Insulation and isolation for main and vertical buses of feeder sections.

H. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

I. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocksPull sections in first paragraph below may be required if incoming supply is beneath switchboard.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
   2. Ground Bus: 1/4-by-2-inch-hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
   5. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
   1. Fuses, rated at 200-kA interrupting capacity.

2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Four-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277-V, three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277.
2. Line to Ground: 1200 V for 480Y/277.
3. Neutral to Ground: 1200 V for 480Y/277.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
   f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in other sections.

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
a. Instantaneous trip.
b. Long- and short-time time adjustments.
c. Ground-fault pickup level, time delay, and I^2t response.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in other sections.
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 120-V ac.

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Impulse-Totalizing Demand Meter:
1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording five-minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.7 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in other sections.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in the International Building Code.

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in other sections. Drawings indicate general arrangement of bus, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in other sections.

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in other sections.

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in other sections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:
1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified inother sections.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Load centers.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.
   7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in the International Building Code:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboardsSubmit final versions after load balancing**.**

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five > years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in the International Building Code.

B. Enclosures: Flush- and surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 >.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
4. Finishes:
a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. However, if the short-circuit & coordination study requires higher AIC rating, then the contractor shall provide higher rated panels without any additional cost to the owners. It is highly recommended that the short-circuit & coordination study be prepared prior to ordering the panels.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
f. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
g. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
h. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Comply with mounting and anchoring requirements specified in the International Building Code.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire tiesafter completing load balancing.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements in other sections.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in other sections.

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in other sections.

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 13 - ELECTRICITY METERING

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 equipment for electricity metering by utility company and electricity metering by Owner.

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For electricity-metering equipment.
   1. Dimensioned plans and sections or elevation layouts.
   2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
   1. Comply with requirements of utilities providing electrical power services.
   2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. E-Mon; a division of Hunt Power.
   2. National Meter Industries.
   3. Osaki Meter Sales, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Quadlogic Submetering.

B. General Requirements for Owner's Meters:
   1. Comply with UL 1244.
   2. Meters used for billing shall have an accuracy of 0.2] percent of reading, complying with requirements in ANSI C12.20.
   3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
   4. Identification: Comply with requirements in other sections.
   5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
   6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
      a. Type: Split core.
   7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
   8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

C. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.
   1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
   2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.

D. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
   1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
   2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours, current time and date**,** current demand, and historic peak demand**,** and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with requirements in other setions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in other sections.
   1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
   2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
   2. Turn off circuits supplied by metered feeder and secure them in off condition.
   3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
   4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Isolated-ground receptacles.
5. Tamper-resistant receptacles.
6. Weather-resistant receptacles.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Wall-switch and exterior occupancy sensors.
10. Communications outlets.
11. Pendant cord-connector devices.
12. Cord and plug sets.
13. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Legrand/Pass & Seymour; Wiring Devices & Accessories (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5351 (single), CR5362 (duplex).
      b. Hubbell; HBL5351 (single), HBL5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex), PT5362 (duplex – use with PTRA6STRNA prewired pigtail connector).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; IG5362RN.
      b. Hubbell; IG5362.
      c. Leviton; 5362-IG.
      d. Pass & Seymour; IG5362 (duplex), PTIG5362 (duplex – use with PTRA6STRNA prewired pigtail connector).
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TR8300.
      b. Hubbell; HBL8300SGA.
      c. Leviton; 8300-SGG.
      d. Pass & Seymour; TR8301 (single), TR63H, PTTR63H, (use with PTRA6STRNA prewired pigtail connector).
   2. Description: Labeled shall comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

D. Combination Tamper-Resistant Hospital-Grade Duplex Convenience Receptacles with (2) USB ports, 125 V, 20 A and minimum charging output of 3.1 A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 Supplement SD and Federal Specification W-C-596.
   1. Available Products: Subject to compliance with requirements, provide one of the following:
      a.
      b. Pass & Seymour; TR8384USB (single), TR8300HUSB
      c. Approved Equal
   2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

E. Tamper-Resistant Convenience Receptacles, 125V, 20A: Comply with NEMA WD1, NEMA WD6 configuration 5-20R, UL498 and Federal Specification W-C-596. Prewired pigtail connectors that accommodate Fed Spec receptacles are approved. Must be crimped and welded terminal right angle application connector.
   1. Available Products: Subject to compliance with requirements, provide by one of the following:
      a. Pass & Seymour; TR5351 (single), TR5362 (duplex), PTTR5362 (use with PTRA6STRNA prewired pigtail connector).
      b. Approved Equal.

F. Combination Tamper-Resistant Duplex Convenience Receptacles with (2) USB ports, 125 V, 20 A and a minimum charging output of 3.1 A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
   1. Available Products: Subject to compliance with requirements, provide by one of the following:
      a. Pass & Seymour; TR5351USB (single), TR5362USB
      b. Approved Equal

G. USB charging receptacle with (4) USB ports and minimum charging output of 4.2 A. Complies with requirements of UL1310.
   1. Available Products: Subject to compliance with requirements, provide by one of the following:
      a. Pass & Seymour; TM8USB4*CC6
      b. Approved Equal.

H. Tamper-Resistant Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
   1. Available Products: Subject to compliance with requirements, provide by one of the following:
      a. Pass & Seymour; TRIG5362 (duplex)
      b. Approved Equal.
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

I. Tamper-Resistant Isolated-Ground Hospital-Grade Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 Supplement SD and Federal Specification W-C-596.
   1. Available Products: Subject to compliance with requirements, provide by one of the following:

a. Pass & Seymour; TRIG8300
b. Approved Equal.

2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

J. Weather-Resistant Convenience Receptacles, 125V, 20A: Comply with NEMA WD1, NEMA WD6 configuration 5-20R, UL498 and Federal Specification W-C-596. Prewired pigtail connectors that accommodate Fed Spec receptacles are approved. Must be crimped and welded terminal right angle application connector.

1. Available Products: Subject to compliance with requirements, provide by one of the following:
   a. Pass & Seymour; WR5362 (duplex).
   b. Approved Equal

K. Tamper-Resistant Power Indicator Hospital-Grade Duplex Convenience Receptacles, 125V, 20A: Comply with NEMA WD1, NEMA WD6 configuration 5-20R, UL498 Supplement SD and Federal Specification W-C-596. Green LED illumination signifying power indication visible with two 3-wire hospital grade plugs engaged. Prewired pigtail connectors that accommodate Fed Spec receptacles are approved. Must be crimped and welded terminal right angle application connector.

1. Available Products: Subject to compliance with requirements, provide by one of the following:
   a. Pass & Seymour; TR8300HPI, PTTR8300HPI (use with PTRA6STRNA prewired pigtail connector).
   b. Approved Equal
2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

L. Controlled Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596. Controlled receptacle marking permanently printed, molded, or stamped on the face of the receptacle and in compliance with Controlled Receptacle Marking requirements stated in Article 406.3(E) of the 2014 National Electrical Code. Prewired pigtail connectors that accommodate Fed Spec receptacles are approved. Must be crimped and welded terminal right angle application connector.

1. Available Products: Subject to compliance with requirements, provide by one of the following:
   a. Pass & Seymour; 26352CD, PT26352CD (use with PTRA6STRNA prewired pigtail connector), 26352CH (half-controlled for split circuit installations), PT26352SCCH (use with PTRA6STRNA prewired pigtail connector)
   b. Approved Equal

M. Tamper-Resistant Controlled Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596. Controlled receptacle marking permanently printed, molded, or stamped on the face of the receptacle and in compliance with Controlled Receptacle Marking requirements stated in Article 406.3(E) of the 2014 National Electrical Code. Prewired pigtail connectors that accommodate Fed Spec receptacles are approved. Must be crimped and welded terminal right angle application connector.

1. Available Products: Subject to compliance with requirements, provide by one of the following:

a. Pass & Seymour; TR26362CD, PTTR26362CD (use with PTRA6STRNA prewired pigtail connector), TR26362CH (half-controlled for split circuit installations), PTTR26362SCCH (use with PTRA6STRNA prewired pigtail connector)
b. Approved equal

N. Controlled Receptacle with Integral Relay and Radio Frequency Communication, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498B and Federal Specification W-C-596. Receives ON/OFF signal from occupancy sensor to turn plug load relay ON/OFF. Controlled receptacle marking permanently printed, molded, or stamped on the face of the receptacle and in compliance with Controlled Receptacle Marking requirements stated in Article 406.3(E) of the 2014 National Electrical Code.
1. Available Products: Subject to compliance with requirements, provide by one of the following:
a. Pass & Seymour; RF26352CD (use with RF Signal Pack "RFP" and 24Vdc power pack and sensor), RF26352CH (half-controlled for split-circuit installations - use with RF Signal Pack "RFP" and 24Vdc power pack and sensor).
b. Approved Equal

2.4 GFCI RECEPTACLES

A. General Description:
1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; VGF20.
b. Hubbell; GFR5352L.
c. Pass & Seymour; 2097, 2097 (NAFTA Compliant), PT2097 (use with PTRA6STRNA prewired pigtail connector), PT2097NA (NAFTA Compliant - use with PTRA6STRNA prewired pigtail connector).
d. Leviton; 7590.

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; GFTR20.
b. Pass & Seymour; 2097TR, 2097TRNA (NAFTA Compliant) PT2097TR (use with PTRA6STRNA prewired pigtail connector), PT2097TRNA (NAFTA Compliant - use with PTRA6STRNA prewired pigtail connector).

2.5 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.
1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 5362BLS.

b. Hubbell; HBL5362SA.
c. Leviton; 5380.
d. Pass & Seymour; 5362BLSP, PT5362SP (duplex – use with PTRA6STRNA prewired pigtail connector).

2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

C. Isolated-Ground, Duplex Convenience Receptacles:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; IG5362BLS.
b. Hubbell; IG5362SA.
c. Leviton; 5380-IG.
d. Pass & Seymour; IG5362BLSP, PTIG5362SP (duplex – use with PTRA6STRNA prewired pigtail connector). .
2. Description:
a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

D. Tamper-Resistant Duplex Surge Protective Devices - Convenience Receptacles:
1. Available Products: Subject to compliance with requirements, provide by one of the following:
a. Pass & Seymour TR5362SP, PTTR5362SP (duplex – use with PTRA6STRNA prewired pigtail connector).
b. Approved Equal
2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

E. Isolated-Ground Tamper-Resistant Duplex Surge Protective Devices - Convenience Receptacles:
1. Available Products: Subject to compliance with requirements, provide by one of the following:
a. Pass & Seymour TRIG5362SP
b. Approved Equal
2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Comply with UL 498 Supplement SD. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; CWL520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; IGL520R.
b. Hubbell; IG2310.

c. Leviton; 2310-IG.
d. Pass & Seymour; IG4700.

2. Description:
   a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description:
   1. Matching, locking-type plug and receptacle body connector.
   2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
   3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
   4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
   3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Single Pole:
      b. Cooper; AH1221.
         a) Hubbell; HBL1221.
         b) Leviton; 1221-2.
         c) Pass & Seymour; CSB20AC1.
      2) Two Pole:
         a) Cooper; AH1222.
         b) Hubbell; HBL1222.
         c) Leviton; 1222-2.
         d) Pass & Seymour; CSB20AC2.
      3) Three Way:
         a) Cooper; AH1223.
         b) Hubbell; HBL1223.
         c) Leviton; 1223-2.
         d) Pass & Seymour; CSB20AC3.
      4) Four Way:
         a) Cooper; AH1224.

b) Hubbell; HBL1224.
c) Leviton; 1224-2.
d) Pass & Seymour; CSB20AC4.

2.10 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable [slider]; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module. . 700, 1600 & 2000W dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."
1. 700W: Pass & Seymour CD700 Series (slide-to-OFF); CD703P Series (Preset)
2. 1100W: Pass & Seymour CD1100 Series (slide-to-OFF); CD1103P Series (Preset)
3. 1600W: Pass & Seymour CD1600 Series (slide-to-OFF); CD1603P Series (Preset)
4. 2000W: Pass & Seymour CD2000 Series (slide-to OFF); CD2003P Series (Preset)

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
1. Pass & Seymour CDFB Series (2-wire, slide-to-OFF); CDFB-3P Series (2-wire, Preset)
2. Pass & Seymour CD3FB Series (3-wire, slide-to-OFF); CD3FB-3P Series (3-wire, Preset)
3. Pass & Seymour CD4FB Series (4-wire, slide-to-OFF); CD4FB-3P Series (4-wire, Preset)

2.11 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.12 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening

2.13 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand.

3. Thomas & Betts Corporation.
4. Wiremold/Legrand.

B. Description:
1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks complying with requirements in Section 27 15 00 "Communications Horizontal Cabling."
4. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.14 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold/Legrand.

B. Description:
1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:
1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: 12 inches.
3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

2.15 SERVICE POLES

A. Description:
1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
2. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
4. Finishes: Manufacturer's standard painted finish and trim combination.
5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.

6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
7. Voice and Data Communication Outlets: Blank insert with bushed cable opening complying with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.16 FINISHES

A. Device Color:
1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with requirements in other sections.

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 26 28 13 - FUSES

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. Cartridge fuses rated 600-V ac and less for use in *control circuits* and enclosed switches

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F >, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Service Entrance: Class L, time delay.
   2. Feeders: Class L, time delay.
   3. Motor Branch Circuits: Class RK1, time delay.
   4. Other Branch Circuits: Class RK1, time delay.
   5. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in other sections and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Shunt trip switches.
   4. Molded-case circuit breakers (MCCBs).
   5. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

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

D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Compression type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.
9. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Compression type, suitable for number, size, and conductor material.

7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, > with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:
   1. Oiltight key switch for key-to-test function.
   2. Oiltight red ON pilot light.
   3. Isolated neutral lug; 100 percent rating.
   4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
   5. Form C alarm contacts that change state when switch is tripped.
   6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
   7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

F. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

G. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
11. Electrical Operator: Provide remote control for on, off, and reset operations.
12. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in the International Building Code.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in other sections.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:
   1. Full-voltage manual.
   2. Full-voltage magnetic.
   3. Reduced-voltage magnetic.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
   1. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:
   1. Routine maintenance requirements for enclosed controllers and installed components.
   2. Manufacturer's written instructions for setting field-adjustable overload relays.
   3. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in the International Building Code.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.11 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Surface mounting.
   4. Red pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
   4. Surface mounting.
   5. Red pilot light.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.

4. Surface mounting.
5. Red pilot light.
6. N.O auxiliary contact.

2.2 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.

B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Siemens Energy & Automation, Inc.
d. Square D; a brand of Schneider Electric.
2. Configuration:
a. Wye-Delta Controller (use for chillers and large air-conditioning units): Four contactors, with a three-phase starting resistor/reactor bank.
b. Autotransformer Reduced-Voltage Controller (use for centrifugal pumps, fans, compressors and conveyors): Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
3. Contactor Coils: Pressure-encapsulated type.
a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120 >-V ac; obtained from integral CPT, with primary and secondary fuses, with CPTof sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
a. CPT Spare Capacity: 100 VA.
6. Bimetallic Overload Relays:
a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.
7. N.C, isolated overload alarm contact.
8. External overload reset push button.

C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Siemens Energy & Automation, Inc.
d. Square D; a brand of Schneider Electric.
2. Fusible Disconnecting Means:
a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.

b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

3. Nonfusible Disconnecting Means:
   a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 4X.
   3. Kitchen Areas: Type 4X, stainless steel.
   4. Other Wet or Damp Indoor Locations: Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
   6. Hazardous Areas Indicated on Drawings: Type 7 .

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
      a. Push Buttons: Covered types; maintained as indicated.
      b. Pilot Lights: LED types; colors as indicated**;** push to test.
      c. Selector Switches: Rotary type.
   2. Elapsed Time Meters: Heavy duty with digital readout in hours**;** nonresettable.
   3. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. N.C auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

H. Cover gaskets for Type 1 enclosures.

I. Terminals for connecting power factor correction capacitors to the line] side of overload relays.

J. Spare control wiring terminal blocks, quantity as indicated**;** wired.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with requirements in other sections.

B. Seismic Bracing: Comply with requirements specified in the International Building Coode.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch enclosed controller.

E. Install fuses in control circuits if not factory installed. Comply with requirements in other sections.

F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in other sections.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in other sections.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed controllers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere

ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers at 50 percent.

E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

F. Set field-adjustable circuit-breaker trip ranges.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION

SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. MCP: Motor-circuit protector.

H. NC: Normally closed.

I. NO: Normally open.

J. OCPD: Overcurrent protective device.

K. PCC: Point of common coupling.

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. TDD: Total demand (harmonic current) distortion.

P. THD(V): Total harmonic voltage demand.

Q. VFC: Variable-frequency motor controller.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of enclosed unit.
      f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
      g. Specified modifications.
   2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Qualification Data: For qualified testing agency.

C. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC, from manufacturer.

E. Source quality-control reports.

F. Field quality-control reports.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for setting field-adjustable overload relays.
   2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   3. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in the International Building Code.

1.9 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
   2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
   3. Humidity: Less than 95 percent (noncondensing).
   4. Altitude: Not exceeding 3300 feet.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.11 COORDINATION

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

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Danfoss Inc.; Danfoss Drives Div.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   3. Siemens Energy & Automation, Inc.
   4. Yaskawa Electric America, Inc; Drives Division.

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range maximum voltage equals input voltage.

G. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
   7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
   8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
   9. Humidity Rating: Less than 95 percent (noncondensing).
   10. Altitude Rating: Not exceeding 3300 feet.
   11. Vibration Withstand: Comply with IEC 60068-2-6.
   12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   14. Speed Regulation: Plus or minus 5 percent.
   15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.

J. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.

4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

E. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
      b. A minimum of six multifunction programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      a. 0- to 10-V dc.
      b. 4- to 20-mA dc.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
   3. Output Signal Interface: A minimum of one programmable analog output signal(s) 4- to 20-mA dc), which can be configured for any of the following:
      a. Output frequency (Hz).
      b. Output current (load).
      c. DC-link voltage (V dc).
      d. Motor torque (percent).
      e. Motor speed (rpm).
      f. Set point frequency (Hz).
   4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Set point speed reached.
      c. Fault and warning indication (over temperature or overcurrent).

d. PID high- or low-speed limits reached.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Provide input filtering, as required, to limit TDD and THD (V) at the defined PCC per *IEEE 519*.

B. Output Filtering: Provide TCI KDR Optimized drive reactors filter with high impedance for lead lengths less than 100 feet. Provide TCI KLC/KLCUL output filter and KMG motor guard high performance output filter for lead lengths more than 100 feet.

2.4 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller**;** with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Reduced-voltage (autotransformer) type.
1. NORMAL/BYPASS selector switch.
2. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
3. Contactor Coils: Pressure-encapsulated type.
a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
a. CPT Spare Capacity: 100 VA.
5. Overload Relays: NEMA ICS 2.

a. Solid-State Overload Relays:
   1) Switch or dial selectable for motor-running overload protection.
   2) Sensors in each phase.
   3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
b. NC isolated overload alarm contact.
c. External overload reset push button.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 4X.
   3. Kitchen Areas: Type 4X , stainless steel.
   4. Other Wet or Damp Indoor Locations: Type 4 .
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oil tight type.
      a. Push Buttons: Covered types; maintained.
      b. Pilot Lights: LED types; Red color**;** push to test.
      c. Selector Switches: Rotary type.

B. NC bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
   1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:
   1. Elapsed-time meter.
   2. Kilowatt meter.
   3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with stainless steel intake and exhaust grills; 120 -V ac; obtained from integral CPT.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2 or latest NEMA standards.
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

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

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with requirements in other sections.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
   1. Curbs and roof penetrations are specified in other sections.
   2. Structural-steel channels are specified in other sections.

D. Seismic Bracing: Comply with requirements specified in the International Building Code.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in other sections.

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in other sections.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation Test and adjust controllers, components, and equipment**.**
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFCs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in other sections..

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
   1. Diesel engine.
   2. Unit-mounted cooling system.
   3. Unit-mounted control and monitoring.
   4. Performance requirements for sensitive loads.
   5. Outdoor enclosure.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.
   2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
   2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   4. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in The International Building Code. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Qualification Data: For installer and testing agency.

C. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. 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.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

J. Comply with UL 2200.

K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 40 deg C.
2. Altitude: Sea level to 1000 feet.

B. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:
1. High salt-dust content in the air due to sea-spray evaporation.

1.9 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Caterpillar; Engine Div.
2. Generac Power Systems, Inc.
3. Kohler Co.; Generator Division.
4. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated.
   2. Output Connections: Three-phase, four wire.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
   2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
   3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
   4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
   6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
   8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 40 feet from exhaust discharge after installation is complete shall be 60 dBA or less and shall meet the maximum allowable sound attenuation level set forth by the authority having jurisdiction.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
   1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
      a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
   2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
   3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
   4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
   5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
   6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
   7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
   1. Tank level indicator.
   2. Capacity: Fuel for eight hours' continuous operation at 100 percent rated power output.
   3. Vandal-resistant fill cap.

4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in other sections.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
   1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
   2. Trip Settings: Selected to coordinate with generator thermal damage curve.
   3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
   4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
   1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
   2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
   3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
   4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, sound attenuating enclosure (meeting the maximum allowable sound attenuation level indicated in section 2.3.I.2. above), wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
   1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
   2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.9 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of 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.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in other sections.

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in other sections.
   1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in other sections.

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

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

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in other sections.

F. Ground equipment according to requirement in other sections.

G. Connect wiring according to requirement in other sections.

3.4 IDENTIFICATION

A. Identify system components according to requirement in other sections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
      c. Verify acceptance of charge for each element of the battery after discharge.
      d. Verify that measurements are within manufacturer's specifications.
   4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
   5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
   7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
   8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
   9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to requirement in other sections.

END OF SECTION

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in The International Building Code. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing

Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

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

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.7 PROJECT CONDITIONS

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Emerson; ASCO Power Technologies, LP.
2. Generac Power Systems, Inc.
3. GE Zenith Controls.
4. Onan/Cummins Power Generation; Industrial Business Group.
5. Russelectric, Inc.
6. Transfer Switches Using Molded-Case Switches or Circuit Breakers:
7. AC Data Systems, Inc.
8. Eaton Electrical Inc.; Cutler-Hammer.
9. GE Zenith Controls.
10. Hubbell Industrial Controls, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Transient Voltage Surge Suppressions (TVSS): Provide integral TVSS in accordance with other sections.

F. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

I. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

J. Battery Charger: For generator starting batteries.
   1. Float type rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in other sections.
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

M. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees.

Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

F. Automatic Transfer-Switch Features:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
   7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
      a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
      b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
   8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
   9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
   10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
   11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
   12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
      a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
      b. Push-button programming control with digital display of settings.
      c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.

B. Identify components according to requirements in other sections.

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Ground equipment according to requirements in other sections.

B. Connect wiring according to requirements in other sections.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to requirements in other sections.

B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection for structures.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For air terminals and mounting accessories.
   1. Layout of the lightning protection system, along with details of the components to be used in the installation.
   2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
   1. Ground rods.
   2. Ground loop conductor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.

B. System Certificate:
   1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class II, copper unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ERICO International Corporation.
      b. Heary Bros. Lightning Protection Co. Inc.
      c. Preferred Lightning Protection.
      d. Thompson Lightning Protection, Inc.
   2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
   3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

C. Main and Bonding Conductors: Copper.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:
   1. System conductors.
   2. Down conductors.
   3. Interior conductors.
   4. Conductors within normal view of exterior locations at grade within 200 feet of building.

D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
   1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.
   1. Bury ground ring not less than **24 inches** from building foundation.
   2. Bond ground terminals to the ground loop.
   3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

I. Coordinate installation with PV panels on roof areas. Provide 12" air terminals and offset base at solar panel. Location of mid-roof air terminals on solar panels shall be determined at job site.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in other sections.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION

SECTION 26 43 13 – TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPD/TVSS for low-voltage (120 to 600 V) power distribution and control equipment.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. VPR: Voltage protective rating.

C. SPD/TVSS: Surge Protective Device/Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Certificates: For SPD/TVSS devices, from manufacturer.

C. Field quality-control reports.

D. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: OSHA approved NRTL.

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

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with UL 1283 and UL 1449.

E. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

A. Service Conditions: Rate SPD/TVSS devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage. The MCOV value shall be a tested value as outlined in the nominal discharge current test of UL 1449 3rd Edition section 37 .7 .3 MCOV values based on the

componenet's MCOV value or on the 30 minute 115% operational voltage test, section 38 of UL 1449 3rd Edition will not be accepted.

2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.9 COORDINATION

A. Coordinate location of field-mounted SPD/TVSS devices to allow adequate clearances for maintenance.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Ten years from date of Substantial Completion.

B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Current Technology Inc.; Danaher Power Solutions.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   4. Liebert Corporation; a division of Emerson Network Power.
   5. Siemens Energy & Automation, Inc.
   6. Square D; a brand of Schneider Electric.
   7. Surge Suppression Incorporated.

B. Surge Protection Devices:
   1. Comply with UL 1449.
   2. Modular design (with field-replaceable modules) or Non-modular design.
   3. SPD system rated at 200-kA interrupting capacity. Fabrication using bolted compression lugs for internal wiring.
   4. Redundant suppression circuits.
   5. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
   6. LED indicator lights for power and protection status.
   7. Audible alarm, with silencing switch, to indicate when protection has failed.
   8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   9. Four-digit transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
   1. Line to Neutral: 125,000 A.

2. Line to Ground: 125,000 A.
3. Neutral to Ground: 125,000 A.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V or 800 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 1000 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V or 1000 V for 208Y/120 V.

2.2 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology Inc.; Danaher Power Solutions.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation; a division of Emerson Network Power.
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric.
7. Surge Suppression Incorporated.

B. Surge Protection Devices:
1. Comply with UL 1449. 3rd Edition
2. Modular design (with field-replaceable modules)or Non-modular design].
3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
4. SPD system rated at 200-kA interrupting capacity. Fabrication using bolted compression lugs for internal wiring.
5. Redundant suppression circuits.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Four-digit transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 60 kA per mode/120 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
1. Line to Neutral: 80,000 A.
2. Line to Ground: 80,000 A.
3. Neutral to Ground: 80,000 A.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 Vor 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 Vor 800 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 Vor 900 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 Vor 1000 V for 208Y/120 V.

2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

B. Outdoor Enclosures: NEMA 250 Type 4X.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD/TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install SPD/TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
   1. Provide multiple, 60-A circuit breaker as a dedicated disconnecting means for SPD/TVSS unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
   2. After installing SPD/TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
   3. Complete startup checks according to manufacturer's written instructions.

D. SPD/TVSS device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Do not energize or connect service entrance equipment to their sources until SPD/TVSS devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to maintain SPD/TVSS devices.

END OF SECTION

SECTION 26 51 13 - LIGHTING FIXTURES AND LIGHTING EQUIPMENT

1. GENERAL

A. Furnish and install all lighting fixtures, as herein specified, complete with accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections, apply to this Section.

C. All items furnished shall comply with the latest standards applicable such as U.L., NEMA, etc., and shall bear labels accordingly. All fixtures shall be the color specified or as selected by the Architect. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or fingerprints shall be restored to new condition or shall be replaced.

D. Shop drawings shall be submitted electronically – refer to Division 01. As part of shop drawings provide drawing illustrating interior lighting controls and shading. As part of LEED submittal for SS Credit 8, provide manufacturer's data for exterior lighting, including data on initial fixture lumens above 90 degrees from nadir for all exterior lighting fixtures, and for parking lot lighting, verification that the fixtures are classified by the IESNA as 'full cutoff' (FCO), OR provide documentation that exterior luminaires are IDA-Approved as Dark-Sky Friendly by the International Dark Sky Association (IDA) Fixture Seal of Approval Program. Additionally, provide a description of the light trespass analysis and photometric site plan that includes a footcandle summary table.

E. Locate pendant, surface mounted or chain-hung industrial fixtures in mechanical rooms and similar spaces to avoid ductwork and piping. Locate around and between equipment to maximize the available light. Request a layout from the Engineer if uncertain about an installation.

F. Refer to drawings for acceptable manufacturers. Proposed substitutions must be submitted per Division 00 and Division 01.

G. All reflecting surfaces, glass or plastic lenses, downlighting Alzak cones and specular reflectors shall be handled with care during installation to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

H. Refer to architectural details as applicable for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

I. Warranty shall start at Final Project Completion.

2. VOLTAGE

A. All lighting fixtures will be rated 277 volts, single phase as indicated or required.

3. LED FIXTURES

LED SOURCES

A. LED's shall be manufactured by a manufacturer who has produced commercial LEDs for a minimum of five (5) years.
B. Lumen Output – minimum initial delivered lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-360 degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.
C. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours at the rated ambient operating temperature.
D. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
E. LED Boards shall be suitable for field maintenance and have with plug-in connectors. LED boards shall be upgradable
F. Light Color/Quality:
    a) Correlated Color temperature (CCT) range as per specification, between 3000K, 3500K and 4000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
    b) Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.
    c) The color rendition index (CRI) shall be 80 or greater
    d) LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

LED DRIVERS

A. Driver: Acceptable manufacturer: eldoLED, Sylvania, or Philips that meet or exceed the criteria herein.
B. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
C. Driver should be UL Recognized under the component program and shall be modular for simple field replacement.
D. Electrical characteristics: 120 – 277 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.
E. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 percent to 0.1 percent of rated lumen output with a smooth shut off function.
F. Dimming shall be controlled by a 0-10V signal, or if require "DMX".

G. Driver shall include ability to provide no light output when the control signal drops below 0.5 V, and shall consume 0.5 watts or less in this standby.
H. Driver shall be capable of configuring a linear or logarithmic dimming curve.
I. Drivers shall track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range regardless of the controller type
J. Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have: Less than 1 percent flicker index at frequencies below 120 Hz and less than 12 percent flicker index at 120 Hz, and shall not increase at greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz
K. Driver disconnect shall be provided where required to comply with codes.

LED ELECTRICAL

A. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements.
B. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A. To reduce false circuit breaker tripping due to turn on inrush, the following statement ensures that electronic dimming driver will meet NEMA inrush recommendations.
C. Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps2 – seconds.
D. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions
E. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance.
F. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

4. LIGHTING FIXTURE SCHEDULE

A. Refer to the contract drawings for Lighting Fixture Schedule

5. PHOTOCELLS

A. Provide photocell as part of network lighting control system.

B. Mount photocells in locations concealed from sight lines standing on ground unless otherwise noted, in which case the final position shall be as directed by the Architect. Group together (if indicated at one location) and mount on back of parapet wall or otherwise properly support with mounting bracket. Coordinate with roofing installer to ensure that roof penetrations are properly made without violating or reducing the roof warranty in any way. Photocells may be mounted in other locations if it is not practical to install them on roofs or parapets, in which case the Contractor shall request direction for

their mounting locations from the Engineer or Architect. Photocells shall always be mounted in a weatherproof, inconspicuous manner.

C. Photocell shall be connected to network lighting control system for normal control of all building mounted and site lighting – refer to plans for locations.

6. TIMECLOCKS

A. Provide timeclock function as part of network lighting control system.

END OF SECTION

SECTION 26 51 16 - NETWORK LIGHTING SYSTEMS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (occupancy), and manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed)

C. The system architecture shall provide stand-alone groups (rooms) of devices to function in a default capacity even if network connectivity to the greater system is lost. The network shall allow for remote troubleshooting and reporting as well as some higher level functionality.

D. The system shall not require any centrally hardwired switching equipment.

E. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

F. Graphical floor plan software shall be provided allowing the owner to see devices in specific rooms and by clicking on the symbol with a mouse shall be able to see status, make device adjustments, modify schedules, over-ride, and/or disable devices. The software shall also provide a reporting tool that indicates what savings have been accomplished by use of each technology used in a space over a specified time (Occupancy sensing, daylight harvesting, time of day, etc.)

1.4 SUBMITTALS

A. Product Data: For each type of product.

A. Specification Conformance Document: Indicate whether the submitted equipment:
   A. Meets specification exactly as stated.
   B. Meets specification via an alternate means and indicate the specific methodology used.

B. Shop Drawings; include:
   A. Schematic (one-line diagram) of system.
   B. Mounting dimension requirements for each product and mounting condition.

C. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements for all switches, relays, sensors, equipment part of the lighting system.

D. Sequence of Operation to describe how each area operates and how any building wide

functionality is described.

E. Sequence of Operation to describe how each area operates and how any building wide functionality is described.

F. Provide coordination drawings showing interconnecting control wiring and interface devices.

G. Quality Control Submittals:
   A. Test Reports: Indicating compliance with specified fabric properties.
   B. Certification: Morton International Laboratory Report for PVC coated fabrics and bacterial and mildew resistance.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Retain "Testing Agency Qualifications" Paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article. Qualification requirements are in addition to those specified in Section 01 40 00 "Quality Requirements," which also defines "NRTL" (nationally recognized testing laboratory).

B. All steps in sensor manufacturing process shall occur in the USA; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.

C. All components and the manufacturing facility where product was manufactured must be ROHS compliant.

D. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

E. All applicable products must be UL/CUL Listed or other acceptable national testing organization.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation according to NECA 407.

1.8 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

B. Coordinate lighting controls with BAS (if necessary) either through IP based intercommunication of system or hardwired auxiliary relay outputs.

C. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.9 WARRANTY

A. All devices in lighting control system shall have a 5 year warranty. Warranty shall start at Final Project Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. This specification is based on the nLight Network Control System from Sensor Switch, by Watt Stopper or Cooper Controls

2.2 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section)

D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and posses RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5E low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone "bus power supplies" shall not be required in all cases.

J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

K. System shall have one or more primary wall mounted network control "gateway" devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

L. System shall use "bridge" devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the "bridge" devices and all cabling that connects zones to bridge devices.

N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.

O. WiFi-enabled devices shall be capable of current monitoring

P. WiFi-enabled devices shall utilize WPA2 AES encryption

Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks

R. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi- enabled system devices

S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

T. Individual lighting zones shall be capable of being segmented into several "local" channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

U. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.

V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

W. A taskbar style desktop application shall be available for personal lighting control.

X. An application that runs on "smart" handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control.

Y. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

Z. Control software shall enable integration with a BMS via BACnet IP.

AA. System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Control Module (Gateway)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet. Provide Network connection from building as needed at head end - Coordinate with low voltage installer.

2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.

3. Control device shall have three RJ-45 ports for connection to other backbone devices
(bridges) or directly to lighting control devices.

4. Device shall automatically detect all devices downstream of it.

5. Device shall have a standard and astronomical internal time clock.

6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.

7. Device shall have a USB port

8. Each control gateway device shall be capable of linking 1500 devices to the management software.

9. Device shall be capable of using a dedicated or DHCP assigned IP address.

B. Networked System Occupancy Sensors

1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.

4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable. Provide this type of sensor in all group restrooms.

5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

6. Sensors shall be include two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.

7. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.

8. Sensors shall be available in multiple lens options which are customized for specific applications.

9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue

12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.

14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.

15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

17. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.

18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray). Wall plates shall be brushed stainless steel

19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls

20. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.

21. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection

22. Embedded sensors shall have an optional photocell

23. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.

24. Fixture mount sensors shall be capable of powering themselves via a line power feed.

25. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

26. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).

27. System shall have WiFi enabled fixture mountable sensors available.

28. Embedded sensors shall have an optional photocell and 0-10 VDC dimming output

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).

5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)

6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.

7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.

9. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.

D. Networked System Metering Power (Relay) Packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system and come capable of metering connected load.

3. All devices shall have two RJ-45 ports.

4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.

5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this

requirement, whereas Appliance Control Listing does not meet this safety requirement.

6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

7. Power Packs and Power Supplies shall be available that are WiFi enabled.

8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.

9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.

10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.

11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.

13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.

14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.

15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.

16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.

17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.

18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.

2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.

3. Panel shall provide one 0-10VDC dimming output paired with each relay.

4. Panel shall power itself from an integrated 120/277 VAC supply.

5. Panel shall be capable of operating as either two networked devices or as one.

6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.

7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection

F. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.

2. Devices shall have two RJ-45 ports

3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).

5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.

6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output

7. Specific I/O devices shall sense state of low voltage outdoor photocells

8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

9. Specific I/O devices shall sense .

G. Networked LED Luminaires

1. Networked LED luminaire shall have a mechanically integrated control device

2. Networked LED luminaire shall have two RJ-45 ports

3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)

4. Networked LED luminaire shall provide low voltage power to other networked

control devices

5. System shall be able to turn on/off LED luminaire without using a relay

6. System shall be able to maintain constant lumen output over the specified life of the LED luminarie (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).

7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.

2. Devices shall be available with zero or one integrated Class 1 switching relay.

3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

4. All sensors shall have two RJ-45 ports.

5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.

6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).

7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).

8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.

9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.

10. Devices with mechanical push-buttons shall be made available with custom button labeling

11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

I. Networked System Graphic Wall Station

1. Device shall have a 3.5” full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.

2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.

3. Device shall enable user supplied .jpg screen saver image to be uploaded.

4. Device shall surface mount to single-gang switch box

5. Device shall have a micro-USB style connector for local computer connectivity.

6. Device shall have two RJ-45 ports for communication

J. Networked System Scene Controllers

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

2. Device shall recess into single-gang switch box and fit a standard GFI opening.

3. Devices shall provide LED user feedback.

4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

5. All sensors shall have two RJ-45 ports.

6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.

7. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).

8. Device shall have LEDs indicating current selection.

K. Communication Bridges

1. Device shall surface mount to a standard 4" x 4" square junction box.

2. Device shall have 8 RJ-45 ports.

3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.

4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.4 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the

software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.7 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

2.8 START-UP & SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once

adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

H. Install equipment in accordance with manufacturer’s installation instructions.

I. Provide complete installation of system in accordance with Contract Documents.

J. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

K. Define each dimmer's/relay’s load type, assign each load to a zone, and set control functions.

L. Season lamps at full intensity according to lamp manufacturer’s recommendation.

M. Install equipment in accordance with manufacturer’s installation instructions.

N. Provide complete installation of system in accordance with Contract Documents.

O. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

P. Define each dimmer's/relay’s load type, assign each load to a zone, and set control functions.

Q. Season lamps at full intensity according to lamp manufacturer’s recommendation.

R. Install plenum cable in environmental air spaces, including plenum ceilings.

S. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

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

U. 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.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Acceptance Testing Preparation:

1. Test continuity of each circuit.

D. Lighting control panel will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time- of-day schedules, and input override assignments.

B. Required factory-trained personnel site visits:

1. Pre-installation: The system shall be provided with visits from factory trained technician(s) for a pre-installation visit with the contractor prior to system installation.
2. Commissioning and Programming: A second visit shall be included for commissioning and programming of the system including testing of switches and sensors.
3. Owner Training: A third visit shall be provided for owner training after the owner has occupied the building. Minimum four hour training to be video recorded.
4. Owner Re-Training and System Adjustment: A fourth visit 6 months after the owner has occupied the building shall be provided to tweak the system for occupant preferences and for additional training.

3.6 ADJUSTING

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

3.8 SEQUENCE OF OPERATION

A. Classrooms:

1. The classrooms shall be provided with a control station at the entry door to turn on and dim the zones of lighting in four (4) presets. The first preset shall be labeled “green” and shall turn all lighting on to 30 footcandles. The second preset shall be labeled “AV” and shall turn the lighting closest to the teaching wall on to 10% output with the rest of the lighting at 30% output. The third preset shall be labeled “Full” with all lighting at 100% output. The fourth preset shall be labeled “Low” and shall be all lighting at 10% output. A vacancy sensor shall be provided to turn lights off when no occupancy has been detected for 30 minutes. It shall include auxillary relay contacts to provide occupancy status to the temperature control system.

B. Corridor/Lobbies/Vestibules:

1. The common areas shall be controlled via occupancy sensors. During school hours the switches will be programmed as on only.

C. Restrooms:

1. The restrooms shall be controlled via occupancy sensors.

D. Storage Rooms:

1. The storage rooms shall be provided with a low voltage switch at the entry door allowing the occupant to turn lighting on if needed. The vacancy sensor shall turn the lighting off when no occupancy has been detected for 5 minutes.

E. Gym:

1. The lighting shall be controlled via low voltage touchscreen at entry doors. Time of day scheduling will put the Gym into occupied mode at 6:00AM and into unoccupied mode at 10:00PM. The occupant will be required to turn the lighting on when they enter the space. When not in use, occupancy sensors will control space. Gym should be provided with multiple levels of zones as seen on drawings. Fixtures shall be connected to photosensors and occupancy sensors and zoned per drawings.

F. Media Center:

1. The media center shall be provided with a touchscreen switch at the entry door to turn on all lighting in one zone. A touch screen master control station shall be provided at the media desk to switch and dim separate zones – see plans for zone locations. Photosensors shall be provided to dim the lighting in daylighting zones independently from the rest of the room. Time of day scheduling shall place the room into occupied mode at 5:30AM and shall sweep lighting off after a blink warning at 6:30PM. Fixtures shall be connected to photosensors and occupancy sensors and zoned per drawings.

G. Cafeteria:

1. The cafeteria shall be controlled via the theatrical lighting system.

H. Kitchen:

1. The kitchen shall be controlled via time of day scheduling. It shall be placed in occupied mode at 4:00AM and unoccupied mode at 6:30PM. At 6:30 the lighting will be swept off after a blink warning to provide occupants time to hit the switch and receive 90 minutes of additional lighting. Switches shall be placed in locations indicated on drawings to provide 90 minute over-ride to on when necessary. During school hours the switches will be programmed as on only.

3.9 SERVICE AND SUPPORT

A. Provide factory certified field service engineer to make minimum of three site visits to ensure proper system installation and operation under following parameters
   a. Qualifications for factory certified field service engineer:
      1) Minimum experience of 2 years training in the electrical/electronic field.
      2) Certified by the equipment manufacturer on the system installed.
   b. Make first visit prior to installation of wiring. Contractor must schedule meeting

Electrical Engineer and Manufacturer representative to review system and functionality prior to installation of wire and equipment.

c. Make second visit upon completion of installation of Network Lighting Control System for system start up. Schedule start up with owner and engineer with 2 weeks prior notice.

d. A total two (2) Owner training session with the electrical contractor, the lighting controls contractor, the factory authorized representative, engineer of record, and the owner (and staff) shall be conducted at the project site. The training session shall be scheduled a minimum of 2 weeks prior. The training session shall not be conducted until the lighting controls system has been programmed and is fully operational.

e. A total of two (2) walk thrus shall be conducted after completion of construction to assure that the system is fully operational. The walk thrus shall be schedule a minimum of 2 weeks prior and shall be conducted at the request of the owner or engineer of record. In lieu of a formal request from the owner or engineer of record the walk thrus shall be conducted 3 months and 9 months after completion of construction. Reports shall be issued at each walk-thru.

END OF SECTION

SECTION 26 51 22 –PHOTOVOLTAIC SYSTEM

1. GENERAL
   A. RELATED DOCUMENTS
      1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 apply to this Section.
   B. SUMMARY
      1. This Section includes the following:
         a. Framed Crystalline Photovoltaic Cells
         b. Photovoltaic Inverter Equipment
         c. Mounting to Membrane Roof
         d. Photovoltaic Monitoring and Reporting Services
         e. Dual Axis Tracking System
         f. PV canopy
   C. PERFORMANCE REQUIREMENTS
      1. Special Note: Photovoltaic system, as defined by PV Panels, mounting racks, inverters, monitoring system, trackers, canopies and wiring shall be installed by the NABCEP certified installer. No exceptions.
      2. Material Compatibility: Provide photovoltaic, electrical and mounting materials that are compatible with one another under conditions of service and application required, as demonstrated by photovoltaic manufacturer based on testing and field experience.
      3. Design after Award: The contractor shall be responsible for providing complete documentation for system installation. This will include: detailed electrical connection diagrams, detailed communication connection diagrams and structural design of all mounting hardware and supports for the actual project conditions.
      4. The Contractor shall provide a complete functional operating system of the capacity shown on the Drawings and specified herein. The Contractor is responsible for all connections, wiring, conduit, supports and miscellaneous items necessary to provide a complete and Code compliant system.
      5. Contractor shall provide all misc. voltage / circuit breakers needed for connection to
   D. SUBMITTALS
      1. Product Data: For each type of product indicated.
      2. Shop Drawings: For photovoltaic system. Include scaled plans, elevations, sections, details, attachments to other work, and interconnect wiring diagrams specific to this job and its specific equipment.
      3. Maintenance Data: For roofing system to include in maintenance manuals.
      4. Warranties: Sample copy of Special Warranties to be issued including coverage items and terms as specified in this Section.

5. Inspection Report: Copy of photovoltaic installer's inspection report of completed photovoltaic installation.
6. Provide all necessary paperwork under the local utility company and pay all applicable fees for application.

E. QUALITY ASSURANCE

1. PV Installer Qualifications: A NABCEP certified installer who is, authorized, or licensed by photovoltaic system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
2. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by UL. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
   a. Exterior Fire-Test Exposure: Class C;
3. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to PV system including, but not limited to, the following:
   a. Meet with Owner, Architect, photovoltaic installer, and other installers whose work interfaces with or affects photovoltaic installation including installers of electrical components.
   b. Review methods and procedures related to photovoltaic installation, including manufacturer's written instructions.
   c. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review governing regulations and requirements for insurance and certificates if applicable.
   e. Review temporary protection requirements for roofing system during and after installation.

F. DELIVERY, STORAGE, AND HANDLING

1. Deliver photovoltaic materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

G. PROJECT CONDITIONS

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit photovoltaic system to be installed according to manufacturer's written instructions and warranty requirements.

H. WARRANTY

1. Component Warranty:

a. Photovoltaic panels: 10 year material at 90% power output
25 year material at 80% power output

b. AC Inverter and Combiner: 10 year material

c. Photovoltaic mounting structure: 10 year material

d. Photovoltaic mounting structure: 5 year finish

2. PRODUCTS

A. MANUFACTURERS

1. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

a. All PV modules shall meet or exceed the requirements of IEEE standard 1262-1995 Recommended Practice for Qualification of Photovoltaic (PV) modules and Underwriters Laboratories (UL) standard 1703 standard for safety for Flat-Plate Photovoltaic module or equivalent standards.

2. Crystalline based photovoltaic cell with anodized aluminum frame. Manufacturers subject to approval: Basis of Design: SunPower E20-327-COM or approved equal.

a. Technology: Mounted Photovoltaic Cells.

b. Cell configuration: (refer to drawings-series connected)

c. Thickness of photovoltaic: 1.81".

d. Photovoltaic Front Protection: 1/8" tempered glass

e. Photovoltaic Frame: Anodized Aluminum alloy type 6063

f. Output cable type: 900 mm length/Multi-Contact connectors

g. Nominal power: (Pmax): Refer to the Drawings.

3. Inverters: Subject to photovoltaic manufacturer approval. Basis of Design: Solectria TL series or approved equal. Refer to W series drawings for exact sizes and locations.

4. Microinverter: Enphase M250 or approved equal

5. Rapid Shutdown String Combiner Box: Solectria ARCCOM or approved equal. Refer to W series drawings for exact locations.

6. Mounting: Subject to photovoltaic manufacturer approval. Winning manufacturer shall provide signed and sealed shop drawings. System is to be provided with all necessary clamping and ballasting components. Renusol EW, SunPower Helix, Orion, or approved equal.

7. All Electrical must be submitted by the approved Electrical Contractor along with a single line drawing showing installation and meet applicable local code.

8. Provide dual axis tracking system - Wattsun DualTrac DA or approved equal as seen on drawings. Dual axis tracker shall be capable of mounting 6 panels (2 columns of 3 panels in portrait). Provide all necessary mounting hardware, clamps, etc.. for complete installation with tracking device. Provide Enphase M250 microinverter for each panel as well as factory cables, clips, terminations, etc… needed for complete installation. Complete system shall be stamped by structural engineer with detailed installation of connection to building structure. Conceal cables as much as possible. Provide Enphase monitoring

system for individual panel readings. Provide 72 cell LG 320, or approve equal, for panels on tracker for integration with microinverter. Provide tracker with power supply and connect to 277v motor circuit accordingly. Coordinate with roofing installer on flashing and penetrations/connections.

9. Provide adjustable tilt mounting for (3) PV panels located on roof at outdoor science classroom. provide WINDY NATION SOL-AJBR-01, or approved equal at three locations on roof. Provide LG320, or approved equal, at panel location. Ballast mount to roof accordingly. Provide each panel with Enphase M250 microinverter and connect each to different phase of circuit for individual monitoring capability. Provide A/C disconnect on wall for shutdown of system.
10. As part of alternate **1A** , provide PV canopy with 24 panels. Provide panels as LSX-250, or approved equal. Provide with all railing, wiring, clips ,mounts, etc… for complete installation. Conceal conductors in railing accordingly. Provide circuit breaker, inverter, etc… as part of alternate.
11. As part of alternate **1B**, provide PV canopy system defined in note 10 above as well as an additional PV canopy with 32 panels. Provide panels as LSX-250, or approved equal. Provide with all railing, wiring, clips ,mounts, etc… for complete installation. Conceal conductors in railing accordingly. Provide circuit breaker, inverter, etc… as part of alternate.

B. SYSTEM MONITORING AND REPORTING

1. Inverter manufacturer shall interface with new PV Monitoring System. Provide in this contract, a web based PV monitoring system E-Gauge or approved equal.
2. Provide capability to monitor and multiple systems independently. Provide the following separate graphs on the monitoring system (provide one graphwith sum of all graphs with representing total production) Provide multiple data acquisition servers as required to incorporate all loads. Provide 480V/120V circuits as required for connection to each monitoring system. Provide network connection for each.
    a. Solar Tracker
    b. Adjustable Panel 1 on outdoor classroom
    c. Adjustable Panel 2 on outdoor classroom
    d. Adjustable Panel 3 on outdoor classroom
    e. Individual sub arrays / inverters on roof
    f. Canopy (as part of either alternate)
    g. In addition to complete building monitoring, where panels are connected to Enphase head-end, provide individual panel readouts through web interface.
3. Variables Monitored
    a. Solar array power production (digital display that shows AC voltage, current, kVA, kVAR, and kW)
    b. Power and energy output
    c. Greenhouse gasses (emissions avoidance)
    d. Inverter status
    e. Inverter faults history

f. Photovoltaic system performance

g. Irradiance

4. Owner training on programming and operations-Minimum 8 hours.

5. As part of PV monitoring contractor should provide 1 year total predicted values at time of shop drawings separated into weekly segments. Once substantial completion has been accepted, contractor to monitor PV system for the next 12 months and provide weekly updated on actual vs predicted values.

3. EXECUTION

A. EXAMINATION

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of photovoltaic system:

a. Verify mounting surface has properly cleaned to receive photovoltaic panels

b. Verify deficiencies in mounting rack that would affect photovoltaic panels are corrected.

B. PREPARATION

1. Clean substrate of dust, debris, moisture, and other substances detrimental to photovoltaic installation according to roofing system manufacturer's written instructions. Remove sharp projections.

2. Approved electrical contractor is to install conduit on roofing membrane to allow for electrical installation.

C. PHOTOVOLTAIC MODULE INSTALLATION

1. Construct mounting structure to manufacturer installation instruction for proper spacing of support legs and weights. Attach photovoltaic panels to mounting brackets and install on mounting rack. Tighten clamps to recommended manufacturer requirements.

2. Utilize PV Wire for all roof-mounted wiring, (USE-2 Not sufficient), Sunbolts or equal.

3. All devices and equipment installed on direct current equipment shall be listed for DC use.

4. Install Monitoring and Reporting Service hardware and software to system manufacturers written instructions. Include consultation time with owner for desired labeling and graphic effects desired for a complete functional monitoring system.

D. USER TRAINING

1. The specialty PV installer is required to conduct a minimum of 4 hours training to the end-user and operator of each system. Topics to be covered in this training include theory of operation, operating requirements, component descriptions, maintenance requirements and schedule, safety precautions, overview of systems manual and record keeping. Training shall be videotaped.

END OF SECTION

SECTION 26-55-61 – THEATRICAL LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications section, apply to work of this section.

B. Division 26 Basic Materials and Methods sections apply to work of this section.

1.2 INTENT

A. The intent of this specification is to provide for furnishing all necessary equipment, as detailed on drawings and/or schedules, for a complete lighting and control system.

1.3 QUALITY CONTROL

A. Equipment specified herein shall be the sole responsibility of a single theatrical systems integrator.

B. The manufacturer of all dimming and control equipment shall have been producing lighting control equipment for at least ten consecutive years.

1.4 APPROVALS

A. The following manufactures are the basis of design and shall be considered approved:

1. Altman Lighting
2. Acuity Lighting
3. Martin Lighting
4. Performance Electric
5. Philips Entertainment

B. Prior approval is required for alternate proposals.

C. Complete catalog data, specifications, and technical information on alternate equipment must be furnished to the Architect and Owner at least ten business days in advance of the bid date.

1.5 SCOPE

A. The work included under this specification shall cover all labor, materials, and equipment to furnish the lighting control system herein specified.

B. It shall also include the services of a qualified engineer regularly employed by the manufacturer of the system that shall check the installation and ensure its proper operation.

C. No part of the system shall be energized before being so checked and the installation approved. Failure to observe this provision shall automatically relieve the manufacturer of any responsibility concerning the proper operation of the system or any part thereof and the replacement of parts that may have been damaged by the premature energizing.

1.6 SUBMITTALS

A. On the dimming system, bidders submitting other equipment shall include all pertinent information showing in what respect the system will function in accordance with the specifications. In the case of substitution of the control system, the bidder shall submit the name of the manufacturer and a list of three or more operating systems (with names and telephone numbers of contacts).

B. All fixtures supplied shall meet or exceed the mechanical, electrical, optical, and performance data published for the equipment listed herein.

C. Provide cut sheets for all controls components and systems.

D. It shall be understood that any additions or revisions of wiring required by the use of substitute equipment shall be the responsibility of the bidder making the substitution.

E. Field commissioning and instructional checkout shall be provided within 21 days of written request by the electrical contractor.

F. If the installation is not sufficiently complete to perform the checkout upon arrival of the factory certified field service technician, all costs for the additional trips shall be paid by the contractor.

1.7 SHOP DRAWING REVIEW AND APPROVAL

A. Shop drawings shall be furnished for approval prior to fabrication of the equipment. A set of drawings shall be returned, appropriately marked, as the approval document.

B. When the installation is complete, the owner shall be supplied with "as built" drawings which shall be incorporated as part of the Operation and Maintenance Manual. Maintenance information shall be provided on all major units and principal components of the system.

1.8 WARRANTY

A. The manufacturer shall warrant his equipment to be free from defects in material and workmanship for a period of twenty-four (24) months after the manufacturer's checkout of the installation.

1.9 STANDARDS

A. All lighting instruments and control system components, where applicable standards have been established shall follow the recommendations of a National Registered Testing Laboratories and the National Electrical Code, and must bear appropriate labels.

B. Manufacturers

1. Provide products by the manufacturers indicated on the drawings and specifications. This apparatus is fully catalogued and described with complete technical data available from the manufacturers.
2. The theatrical lighting and control equipment basis of design is as specified in these documents.
3. The listing of a manufacturer as "equivalent systems" does not imply automatic approval. It is the responsibility of the Electrical Contractor to ensure that any price quotation and products meets or exceed the specifications herein.

PART 2 - PRODUCTS

2.1 THEATRICAL RELAY PANELS

A. Materials and Components

1. NEMA rated enclosure with screw cover or hinged door. Rain tight or oil tight and other NEMA rated versions available.
2. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.
3. LCP input power shall be capable of accepting 120v or 277v without rewiring
4. Control electronics in the low voltage section shall be capable of driving 2 to 48 relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control Normally Open (NO) or Normally Closed (NC) relays.
5. Lighting control system shall be digital and consist of a Master LCP, Slave LCPs, Micro LCPs with up to 4 individual relays, digital switches, digital interface cards and if required, SmartBreaker panelboards. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. Analog systems are not acceptable.
6. The lighting control system is a networked system that communicates via RS485 and includes centralized relay panels, micro relay panels, digital switches, photocells, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the DTC and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that “serves” HTML pages to any authorized

workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital system not acceptable.

B. Standard Output Relays

1. Electrically held, electronically latched SPST relay.
2. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #10AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.
3. Rated at 20 Amp, 277VAC Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.
4. Relays to be rated for 250,000 operations minimum at a full 20a lighting load, use Zero Cross circuitry and be Normally Closed (NCZC). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.
5. Optional relay types available shall include: Normally Open (NO) relay rated for 100,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

C. Interfaces

1. For future expansion capability, system to have available all of the following interfaces. Verify and install only those interfaces indicated on the plans:
   (a) A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.
   (b) Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.
   (c) An interface card that allows the DTC to control up to 32 digital XCI brand thermostats. Programming of thermostats to be able to done locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
   (d) A voice prompted telephone override interface module. Interface module shall accept up to 3 phone lines and allow up to 3 simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes shall be standard with each interface module.
   (e) Software pre-installed to run Unity GX Graphical Interface Software. Unity GX software shall provide via local or remote PC a visual representation of a specific area or the total area of the project. GX full graphic pages shall be designed to the owner's specifications. Owner to provide to manufacturer all necessary files and criteria. Provide ____ GX pages.
   (f) Direct digital interface to SmartBreaker panelboards. Relay panel and SmartBreaker panelboard circuits shall appear on the system software as similar, yet distinct, items and maintain all functions and features of the system software.
   (g) Direct digital interface to DMX 512 based systems. DMX interface shall provide 14 global commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time response from the lighting control system to DMX commands.
   (h) Direct digital interface to building automation systems using DDC protocols such as BACnet and Metasys (N2) that accept on/off commands, time schedules and report status of all relays in all panels in real time. Interface cards shall "self populate" each individual relay and each group to the BAS.nts

D. Approved Manufacturer and Products.

1. Theatrical Relay Rack by Strand Lighting or approved equal.
2. Supply the Following:

Description	Base Quote Quantity
24 Space MLO DMX Relay Enclosure, with 24 – 20A Single Pole Normally Open Relays.	1
Phase Loss Sense Panel, 120V, 3-Phase	1

2.2 SIGNAL PROCESSING RACK

A. General.

1. The auxiliary control panel shall be a surface mounted cabinet free of visible fasteners and shall be of aesthetic appearance.
2. The cabinet shall have a hinged locking door cover to protect and secure internal components.
3. Terminal Strips and necessary electrical and electronic terminations will be included.

B. Components.

1. Internal control components for the panel will be factory assembled and tested.
2. The panel shall contain all necessary wiring and terminations for assembly of panel mount components, including internal power supply, plug strips, and cabling.

3. Provide Wall Mounted, Locking 12U Shallow Rack To Include the Following:

Description	Base Quote Quantity
Architectural Control to DMX Interface, Rack Mount	1
Emergency DMX Bypass Switch, UL924, 4-Way Output	1
eDIN Rack Mount Panel to Include 30W PSU and (1) 4-Way DMX Opto Splitter	1
7" LCD Touchscreen For Architectural Control	1
Custom Panel with (1) DMX Output Receptacle, (1) DMX Input Receptacle, and (1) NEMA 5-20 Duplex Receptacle	1
The Following Is To Be Mounted Internally:	
NEMA 5-15 Duplex Receptacle in Back Box.	1

2.3 CONTROL CONSOLE SPECIFICATION

A. Overview.

1. The control console shall be a microprocessor based lighting system designed specifically for the control of theatrical, television, and live performance dimming systems.

B. Channel Capacity.

1. The console shall support the processing of up to 512 total DMX512 outputs with the Starter or Pro 512 console or 1024 total DMX512 outputs with the Pro1024 console.
2. Communication to system devices over a network shall be available utilizing the Pathport protocol with Starter console. The Pathport, E1.31 sACN, and Art-Net protcols shall be available on the PRO512 and PRO1024 console.

C. Mechanical.

1. The console shall consist of a free standing tabletop console with integrated 7" capactivite touchscreen, 4 Encoders, and 20 Fader handles. Consoles that do not include 7" integrated touchscreen shall not be accepted.
2. The control surface shall be designed for table or rack mounting with removable end pieces to facilitate this.

D. Electrical.

1. Console shall be powered through the use of an independent power supply with a molded plug appropriate to the specific geographic locale of use or Power-Over-Ethernet. Control consoles that are unable to be powered by Power-Over-Ethernet shall not be accepted.

2. The following data input/output connectors shall be provided:

    a. (2) DMX512 Out (5-pin XLR - Female).
    b. (1) DMX512 In (5-pin XLR - Male).
    c. (1) RJ-45 Network cable port for Art-Net communication protocol.
    d. (2) USB Port.
    e. (3) Contact Closure

3. The power supply shall be UL, cUL listed and the entire system shall be CE marked.

E. Operational Overview.

1. These consoles are touchscreen drivern control desk that has submaster storage, memory playback, effects storage and playback and additional advanced features specifically engineered for LEDs and moving lights.

F. Operational Features.

1. The system shall be available to patch any dimmer or group of dimmers to a single channel. It shall be possible to set every dimmer with a level (0% to 100%) that shall scale the channel level proportionally.
2. Grand Master and Blackout Switch: the entire system output shall be mastered by this potentiometer and switch.
3. Flash Switches: a "bump" button with a LED indicator associated with each channel or scene potentiometer shall be provided to flash channels or scenes to a level set by the flash level potentiometer. These switches shall be instructed to operate in a flash or solo fashion. When the console is in record mode, the switches shall be used for rapid recording the total live output into a selected submaster.
4. It shall be possible to create and edit Scenes and Effects either Live or in a Preview mode.
5. Playback Controls: playback of channels shall be provided via manual channel faders, submasters, manual scene masters, effects playback, LED mode or Moving Light mode.

    a. The Preset mode A/B manual split crossfader shall have separate incoming and outgoing preset controllers to provide a dipless crossfade between the two manual potentiometers.
    b. The submaster mode A/B manual split crossfader shall have separate incoming and outgoing preset controller to provide a dipless crossfade between sequential and/or non-sequential recorded submasters.
    c. The Time fader potentiometers shall enable timed fades between 0 (manual) and 10 minutes. Timed crossfades may be stopped, paused and continued, manually over-ridden or reversed at any time prior to fade completion.

G. Operating Environment.

1. The console should be operated under general office level conditions, with a minimum of dust.

2. The maximum operating ambient temperature shall be 32 - 104 degrees Fahrenheit (0 - 40 degrees Celsius).
3. The relative humidity shall be 0% - 95% (non-condensing).

H. Included Furnishings.

1. Universal Power Supply (90 - 240VAC, auto-ranging).
2. Dust Cover.
3. Operation Manual.

I. Approved Manufactures and Products

1. Control Console shall be from Pathway, or Approved Equal
2. Supply the Following

Description	Base Quote Quantity
Pathway Console, Pro 512	1
19” LCD Monitor	1
25’ DMX Cable	1

2.4 DISTRIBUTION

A. Wiring Devices

1. Wiring devices specified shall conform to the following standards of construction:

B. Connector Strips

1. Each section shall consist of a 4" x 4" (102mm x 102mm) 18 gauge steel or aluminum wireway with removable cover sections for access, labeled with circuit numbers
2. Each strip shall have a terminal compartment which shall be factory installed on the right or left end as required and shall contain molded barrier type terminals for feed connection. Knockouts, cables clamps and "Kellums" cable grips shall be provided, when appropriate.
3. Each connector strip shall be provided with 50’ of Multi-Cable appropriate for number of circuits.
4. The strip shall be provided with heavy steel mounting straps on approximately 5' (1.52m) centers, to grip up to 2" (51mm) pipe.
5. Type S or SO, 18" (457mm) cable pigtails shall be secured by strain reliefs and shall be furnished with three pole grounded female receptacles. Flush receptacles are available in lieu of pigtails. Internal wiring shall be rated at 125 C.
6. External finish shall be black powder coat epoxy. The entire unit shall be UL and CSA approved and labeled.

C. Plug Boxes

1. Female receptacles shall be three pole grounded type, flush mounted.
2. Finish shall be baked flat enamel.
3. The unit shall be UL listed and CSA approved in Canada.
4. The surface mounted unit shall weigh 11lbs. (5kg). The recessed unit shall weigh 9lbs. (4kg).
5. The dimensions of the unit shall be 12" x 6" x 5" (305 x 150 x 127mm)

D. Approved Manufacturer and Products.

1. Distribution shall be from Performance Electric, Altman Lighting, or Lex Products.
2. Supply the Following:

Description	Base Quote Quantity
FOH CONNNECTOR STRIP - 20' Connector Strip enclosed in 21' Fixture Cage with (6) 5-20 Duplex Receptacles on (6) 20A Circuits. Connector Strip Shall Also Contain (1) DMX OUT Receptacle.	1
OVERSTAGE CONNECTOR STRIPS - 24' Connector Strip with (6) 5-20 Duplex Receptacles on (6) 20A Circuits. Connector Strip Shall Also Contain (1) DMX OUT Receptacle. Include (9) Single Pipe Mount Brackets and 24' of Batten Pipe.	2

2.5 LED ELLIPSOIDAL SPOTLIGHTS.

A. General

1. The instrument shall be a LED ellipsoidal spotlight as manufactured by Altman Lighting or approved equal.

B. Physical

1. The unit shall be constructed die cast aluminum and sheet metal construction, and finished in black, high temperature powder coated paint. Tools shall not be required for either lamp alignment or cleaning the reflector or lens
2. The following shall be provided:

    a. Thermally insulated knobs and shutter handles
    b. Shutter assembly shall allow for 360° rotation
    c. Locking, 20 gauge stainless steel shutters
    d. Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement
    e. Positive locking, hand operated yoke clutch
    f. Slot with sliding cover for motorized pattern devices or optional iris

C. Performance

1. The unit shall be available in 150w or 250w. The 150w unit shall be convenction cooled.
.
2. The unit shall provide, but not be limited to:

    a. RGBA, RGBW, 3000K, or 5600K as specified in bid documents
    b. 5, 10, 19, 26, 36, 50 degree field angles
    c. High-quality pattern imaging
    d. Adjustable hard and soft beam edges
    e. The unit shall be ETL, cETL, & CE listed and so labeled.

D. Approved Manufacturer and Products.

1. LED Ellipsoidal Spotlight be Altman LED Phoenix, or Approved Equal
2. Supply the Following:

Description	Base Quote Quantity
LED Profile Spot, 26°, 250W, RGBW Array. Supply Fixture with 5' Power-Con to 15A Male Edison Connector, Safety Cable, and Color Frame. Fixture To Be Supplied With Pole Operated Pan/Tilt Mount. Supply Each Fixture With 10' DMX Extension and Power-Con Extension Cable.	10
LED Profile Spot, 50°, 250W, RGBW Array. Supply Fixture with 5' Power-Con to 15A Male Edison Connector, Safety Cable, and Color Frame. Fixture To Be Supplied With Pole Operated Pan/Tilt Mount. Supply Each Fixture With 10' DMX Extension and Power-Con Extension Cable.	5

2.6 LED WASH FIXTURES

A. Overview

1. The luminaire shall be a full spectrum color mixing luminaire employing a red, green, blue, and white LED engine. The engine shall be capable of providing tunable white color temperature matched presets as well as millions of permutations of color.
2. The luminaire shall have a 10 to 60 degree electronic control of spot to flood beam spread with an output in excess of 2,000 lumens.
3. The luminaire shall have an integrated control system that provides local controls offering access to set up parameters, preset color temperatures, stored custom presets, and status reporting.
4. The luminaire shall have control inputs for DMX512 with input/output connectivity
5. The beam will have a soft edge with minimal spill.
6. Tilt adjustment shall be by means of a screw lock system secured by a hand sized insulated "T" handle which also allows one hand adjustment. The yoke position shall be adjustable along the length of the fixture.
7. The fixture is provided with a formed steel yoke with a central hole for a 1/2 inch (M12) suspension bolt set comprising 1/2 inch set screw (M12), nut and two washers.

B. Physical

1. Fixture shall not exceed 266mm when the luminaire is at a zero degree angle (at 90 degrees) to the mounting structure. .
2. The luminaire shall allow for a manual rotation of 360 degrees pan and 270 degrees tilt (through utilization of the sliding yoke) to provide optimum luminaire orientation at all times. Luminaires offering limited range of motion shall not be accepted.
3. The construction of the unit shall be an extruded aluminum, sheet metal and molded engineering grade plastic.
4. Weight shall not exceed 12 lbs. [5.5 kg] luminaire only.

C. Electrical

1. Supply Voltage shall be 100-240VAC nominal
2. The luminaires current draw shall not exceed 151W.

D. Environmental

1. Maximum operating ambient temperature shall not exceed 40 degrees Celsius.
2. A variable speed cooling system shall be employed to maintain the optimal operating temperature of the luminaire.

E. Approved Manufacturer and Products.

1. LED Wash Fixture Shall Be Martin Rush Series, or Approved Equal
2. Supply the Following:

Description	Base Quote Quantity
Martin Rush Par 2 RGBW Zoom. Supply Fixture with 5' Power-Con to 15A Male Edison Connector, C-Clamp, Safety Cable, and Color Frame	14

2.7 SPARES AND ACCESSORIES

A. Provide the following:

Description	Base Quote Quantity
25' DMX Extension Cable	1
15' DMX Extension Cable	2

300’ Roll of Tie-Line 1

PART 3 - SYSTEM COMMISSIONING AND TESTING

A. General

1. Prior to operational checkout, the Electrical Contractor shall confirm the following conditions.

    a. All control stations are installed and terminated per the vendor’s integration drawings.
    b. Availability of owner’s staff for instruction
    c. Space is clear of workmen and may be blacked out for extended periods
    d. Building and equipment feeders are energized
    e. HVAC systems are operational in Control Booths and Dimmer Equipment Spaces
    f. Stage luminaries are installed and connected to the dimming system to confirm that individual dimmed circuits are in operational order
    g. Dimmer rack and all equipment is cleaned and ready for operational check-out.

2. Notify vendor in writing, at least 21days prior to requested startup date, that the system is ready for startup.
3. Costs of additional or repeat visits due to delay, lateness, or negligence on the part of the Electrical Contractor shall be borne by the Electrical Contractor.

B. Fixture Hang and Focus

1. Systems Integrator shall unbox, assemble, address, hang and focus all theatrical lighting fixtures to a plot supplied by end user or lighting designer.

C. Testing

1. The vendor’s Field Service Representative shall complete the following:

    a. Inspect the Electrical Contractor’s installation for conformance to vendor’s instructions.
    b. Confirm all wiring runs and termination and make notes as required.
    c. Make notes and diagrams as needed for completion of As-Built Documents as specified elsewhere in this section. Make note of any deviations from vendor’s directions
    d. Measure incoming voltages at the dimmer rack and record
    e. Configure Dimmer rack, console, stations and other components for proper operation.
    f. Test each wired space of Dimmer Rack for proper operation
    g. Test all control stations, consoles and auxiliary controls for proper operation.
    h. Replace any equipment not operating as specified.

i. Test all load circuits for proper dimming operation, from 0 to 100% with a minimum 500-watt load.

D. Training

1. A knowledgeable representative of the vendor shall instruct the Owner's staff or representatives in the operation and maintenance of the system. This instruction session shall be scheduled to last a minimum of eight (8) hours. These training session shall be broken into two (2) individual training sessions. While it may be possible to schedule this instruction session to coincide with the system checkout, such coincidence shall not be assumed.

END OF SECTION

SECTION 27 05 00 - TELECOMMUNICATIONS PATHWAYS AND SPACES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Telecommunications Room Build out

B. Pathways for Telecommunications Systems

C. Grounding and Bonding for Telecommunications

1.2 REFERENCES

A. Industry Codes, Standards and Methods shall be observed, including the following:

1. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
2. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
3. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
4. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
5. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
6. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
7. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
8. ANSI-J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications
9. ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard
10. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
11. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

B. Comply with all local, state and federal codes for telecommunications installations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Contractor shall outfit all telecom rooms according to T Drawings. Racks and other termination and distribution fields shall be installed according to manufacturer’s guidelines and industry standards.
2. TR and TER layouts shall be approved by school Technology personnel prior to installation of cabling, pathways or termination hardware.

B. Performance Requirements

1. Materials and equipment will be installed in an orderly and precise manner. Clearances between equipment will prevent incidental damage or unsafe conditions.

2. Equipment shall provide proper support and housing of all intended active and non-active components.

3. Refer to Telecom Room Details for precise location of equipment and termination fields.

1.4 SUBMITTALS

A. Product Data

1. Provide product data for all equipment listed in Part 2

2. Equipment data must be submitted in a single package and clearly indicated for efficient review. (by specifications section) Equipment submittals not clearly called out will be rejected without question at the contractor's expense for resubmittal.

3. Product data must be approved by designer and owner prior to purchase and installation of equipment.

B. Shop Drawings

1. Provide scaled drawings to show proposed equipment locations, clearances and administrative labeling of Telecom Rooms and equipment. All fields, racks and cabinets shall be methodically documented and permanently labeled agreed upon by school district.

2. Shop drawings must be approved by the designer and owner prior to purchase and installation of any equipment.

C. As-Built Drawings

1. Contractor shall upon completion of the project, provide a complete set of As-Built drawings. These drawings shall identify room numbers and outlet identification numbers for all low voltage cabling systems. Drawings should also include all IDF and MDF locations with a detailed layout of all racks, patch panels, trays, and wall fields.

2. Additional project information shall include Reline Details of all horizontal and backbone cable routes and pathways.

3. As-builts shall be submitted in electronic CAD format and in hardcopy at the end of the project.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements

1. All equipment shall be installed in a neat and professional manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the school district. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Substitutions

1. Conditions for consideration of “Or Equal” Products: Where products are specified by name and accompanied by the term “or equal”, the proposed “or equal” product will be considered when the following conditions are satisfied.

a. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements

b. Proposed product does not require extensive revisions to the Contract Documents.

c. With the exception of the product name or number and manufacturer’s name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.

d. Proposed product is fully documented and properly submitted.

e. Proposed product has received necessary approvals of authorities having jurisdiction.

f. Proposed product is compatible with and has been coordinated with other portions of the Work.

g. Proposed product provides specified warranty.

2. If proposed product involves more than one contractor, proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

3. Submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

4. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.

5. Submission is accompanied with proposed product’s Manufacturer signed written statement on Manufacturer’s letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.6 WARRANTY

A. Warranty: Installer must provide manufacturer’s warranty without cost to the owner during that time period, including materials, hourly costs, etc.

B. Installer’s warranty shall guarantee workmanship for a period of one year, during which time any deficiency in installation shall be repaired or replaced at no additional cost to the school district. Contractor must respond within 2 business days of written notification.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Distribution Racks and Cabinets

1. Floor Mounted Free Standing 2 Post Racks
   a. Hubbell HPW84RR19
   b. Hubbell HC219CE3N
   c. Hubbell XS1010
   d. Or approved equal from Cooper B-Line, Ortronics and Systimax.
2. Floor Mounted Free Standing 4 Post Racks
   a. Four post aluminum frame with EIA rails
   b. 45 Rack Units
   c. Black
   d. Similar to Ortronics OR-MM67SVR or approved equivalent.
3. Floor Mounted Equipment Cabinet
   a. The cabinet frame shall be constructed of four cold rolled steel components – top, bottom, left and right welded to form a self supporting framework. The side members shall be fabricated from 16ga cold rolled steel. The top and bottom shall be fabricated from 14ga cold rolled steel. The vertical uprights shall have integral cable management channels with provisions for hook and loop or traditional cable ties. The frame shall be bolted to the floor, and side by side to other frames.
   b. The side covers shall be constructed of 19ga cold rolled steel with double bent flanges along the entire perimeter. The side covers shall lift off easily via grip handles assembled to the covers. The side cover shall have clusters of rectangular perforation to accommodate ventilation for equipment providing greater than 100 sq. in. of ventilation.
   c. The front door shall be a window door assembled to the frame via spring-loaded hinges at the top and bottom. The door shall be locking with a unique operator's key. The operator's key shall operate the front door only. The latch shall be flush to the door. The window shall be a .125" acrylic panel secured to a reinforced steel frame.
   d. The rear door shall be a steel door assembled to the frame via spring-loaded hinges at the top and bottom. The door shall be locking with a unique service personnel key. The service personnel key shall operate both the rear and front doors. The latch shall be push button operated. The rear door shall be reinforced and have a cluster of rectangular perforations for ventilation.
   e. The top shall have a removable panel in the center, designed to be replaced with a cooling fan, and six 3" diameter cable entry knockouts; three along each side to route cables directly into vertical cable organizers minimizing the number of bends to the cables.
   f. The bottom panel shall be similarly configured with 6 knockout locations. The cabinet bottom shall also be provided with holes for securing the cabinet to the floor.
   g. The top cover shall accept the mounting of a 250 CFM cooling fan.

h. The cabinet shall be pre-configured for 19” mounting with universal hole spacing per EIA 310 D. The cabinet shall feature three sets of rails, front, center, and rear. The front set of rails shall be 20 rack positions high, from the bottom of the cabinet. The rear and center rails shall be the full internal height. The recess of all three sets of rails shall be adjustable forward and back. The rails shall be tapped for a #10-32 screw. The center rails shall be formed in a ‘C’ profile, 3” deep tapped on both the front and rear flanges so as to provide the functionality of an open frame rack. The front and rear rails shall be an L shape.

i. The entire enclosure shall be finished with a durable polyurethane powder coat – medium texture, and shall be available in black.

4. All racks and cabinets shall be capable of supporting the weight and space of existing and proposed equipment. 30% growth capacity shall be provided in addition to detailed requirements.

5. Racks, cabinets and other termination equipment shall be properly secured to floor with appropriate anchors and bonded to Telecommunications Grounding System.

6. Unit shall be similar to Ortronics OR-DCC422846-00002 or approved equivalent.

7. Provide (1) 8-port transient surge protection strip for each TR and per rack/cabinet in the TER and TRs.

B. Cable Management

1. Horizontal Cable Management

a. Horizontal wire management panels are required for patch panels in certain racks. (See drawings for rack diagrams.)

b. Horizontal cable management shall occupy 1 or 2 rack units, as shown on T Drawings.

c. Similar to OR-MM6HMF1RU or approved equivalent

2. Vertical Cable Management

a. Vertical Cable management shall be provided for all racks. Provide 2 for each rack or cabinet.

b. Cable management shall be – Ortronics OR-60400510, or approved equivalent.

C. Ladder-Type Aluminum Cable Tray (Ladder Rack)

1. All TR and TER locations shall receive ladder-rack style cable tray as shown in T-series drawings for cable distribution.

2. Class 5160 or Chatsworth “TELCO-Style Cable Runway,” 12 inch ladder rack from racks/cabinets from corridor or other wire routing space where indicated on drawings.

D. J-Hooks

1. Basis of Design: Caddy Cat HP

a. Provide 4" (minimum) J-shaped hooks, with smooth beveled edges, for corridor distribution. J hooks for in-room distribution shall be a minimum of 1 5/16” diameter.

b. Include all necessary assemblies, hardware, and components for attachment to sidewall, ceiling, or joist.

c. J Hooks shall be pre-galvanized steel and UL listed.

d. J Hook system shall allow for 20% spare capacity in all cases.

e. All manufacturer load and quantity ratings shall be adhered to in all cases.

E. Conduit (electrical installed)

1. In-wall conduit shall be provided for work in new areas. Refer to T Drawings for conduit details.

2. Conduit bend radii shall follow current TIA/EIA standards for telecommunications.

3. Refer to T drawings for locations and sizes of all sleeves for telecommunications.

F. Gang Boxes

1. In-wall Gang Boxes for low voltage

a. See electrical for back boxes.

G. Surface Mounted Raceway (SMR)

1. Surface mounted split channel raceway for power and data - Wiremold 4000

a. Coordinate all Wiremold for telecom equipment with electrical installer.

b. Provide associated colored connectors (see 271250) and faceplates per manufacturer's recommendations for telecommunications.

c. Coordinate color and finish with architect prior to installation

H. Floor Boxes and Poke-through Device

1. Small Capacity In-floor box

a. Coordinate all floor boxes and poke-through devices for telecom equipment with electrical installer.

b. Floor box shall meet latest UL standards for scrub water resistance

c. Four-Compartment Combination Box similar to Wiremold RBF4 or Wiremold RFB6

d. Top of box shall allow for matching floor finish insert and be constructed of metal

e. Provide all brackets and accessories for proper telecommunications installation.

2. Large Capacity In-floor box

a. Wiremold Evolution Series with flush mounted cover.

3. Poke through

a. Unit shall be similar to Wiremold Evolution Series with 5 gangs

I. Distribution Backboard

1. Plywood

a. ¾" AC-grade plywood shall be provided as shown on T drawing details to line the walls within the TR. The plywood should be provided in 4' x 8' sheets.

b. Plywood shall be void free and painted on all sides with two coats of fire-resistant paint.

J. Electrical Protection for Telecommunications

1. Telecommunications Main Grounding Busbar (TMGB) and Telecommunications Grounding Busbar (TGB)

a. Provide one TMGB in the Telecommunications Equipment Room as shown on T Drawings.

b. Provide a TGB in every Telecommunications Room and distribution cabinet location as shown on T Drawings.

c. The telecom grounding and bonding system shall be bonded to the main electrical ground for the facility.

K. Rack mounted power strip

1. Provide 8 port transient, surge protection strip (UL Listed) for each rack or cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions

1. Contractor shall ensure that sufficient space has been allocated for the installation of all equipment per T Drawings prior to Installation. Clearances and existing equipment should be taken into consideration. If insufficient space exists, the Design consultant should be notified in writing, before proceeding with Installation.

3.2 CUTTING AND PATCHING

A. The contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe or any other work in insulated concrete form (ICF) wall, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

3.3 INSTALLATION

A. Distribution Racks and Cabinets

1. Racks shall be assembled such that mounting rails are exactly perpendicular to the base.
2. Racks shall be secured to the floor using appropriate anchors.
3. Racks shall be grounded to the TGB or appropriate building ground using a minimum #6 grounding wire.

B. Distribution Backboard

1. Securely fasten backboard to wall-framing members to ensure it can support attached equipment.
2. Mount plywood on all available areas where telecommunications equipment may be located.
3. Refer to T Drawings for minimum coverage.

C. Ladder Rack and Cable Tray

1. Ladder rack and cable tray shall be properly secured using manufacturer recommended anchors and connectors.
2. Ladder rack and cable tray shall be routed according to T Drawing floor plans.
3. Ladder rack and cable tray shall be bonded to ground according to ANSI/TIA 607.

D. Firestop

1. Provide re-enterable, non-hardening, intumescent putty, rated for floors or wall, UL approved assembly, with approved packing material for fire stopping inside building cable penetrations thru conduits sleeves.
2. The material used for sealing all openings shall have a fire rating equal to or greater than the floor ceiling, wall or partition material.

E. Sleeves and openings

1. The telecommunications contractor shall provide sleeves through all walls and floors to protect cabling and or raceways installed as part of the telecommunications system. All sleeves shall extend through the respective wall or partition and finish with a connector protective bushing.
2. Sleeves through all fire rated structures shall have appropriate fire stop system.

END OF SECTION

SECTION 27 41 00 - AUDIO VISUAL AND SOUND SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Audio / Visual system for Dining.
   2. Sound System for the Gymnasium.
   3. Music Room Sound Systems

1.2 DEFINITIONS

A. "Communications Network Outlet (CNO)" refers to a collection of one or more mechanical cable termination device for horizontal cable in the work area.
B. "Drop" refers to the vertical transition to a location of one or more CNOs.
C. "Horizontal Cabling" refers to the cabling between and including the work area communications network outlet and the horizontal cross-connect in the telecommunications room.
D. "Jack" refers to a female-style telecommunication receptacle.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

   1. Auxiliary Sound/Video Systems:

      a. Dining AV System - A multi-loudspeaker system with video projector and associated wiring and equipment shall be provided, installed and programmed.

      b. Gymnasium Sound Reinforcement System - A multi-loudspeaker system shall be provided. Clearly label and color code the master volume control for all functions.

      c. Music Room Sound Reinforcement Systems - A multi-loudspeaker system shall be provided. Clearly label and color code the master volume control for all functions.

      d. Hearing Assistance System - Provide a reinforcement system for the hearing impaired in the Gymnasiums and Dining. The hearing assistance system shall be an FM radio system that shall not limit operation to certain seats or areas of the room(s). Provide approximately 20-40 milliseconds of high-quality digital signal delay to help in the localization of the sound source.

   2. All stand alone sound systems must have call override from the Intercom/PA system in the case of an emergency.

B. Performance Requirements

   1. Comply with applicable requirements in Local, State and Federal Codes, TIA/EIA Standards, and BICSI methodology.

   2. Specified cabling system derived from recommendations in approved telecommunications industry codes, standards and methods, including the following documents:

      a. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.

      b. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard

      c. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard

      d. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard

e. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces

f. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard

g. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings

h. ANSI-J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications

i. ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard

j. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition

k. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

1.4 SUBMITTALS

A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.

1. Sound coverage and pressure level diagram for each auxiliary sound system
2. Sound Amplifier
3. Sound Speakers
4. Sound Microphones
5. Sound Cabling and Wiring
6. Audio Visual cables and connectors
7. DSP Units
8. A/V switchers
9. A/V controllers
10. Signal Extenders
11. A/V Mixers
12. Communications outlets, faceplates, and accessories.
13. Wall outlets

C. Samples: Provide samples of equipment, cables, microphones and assemblies as described below, prior to installation, for approval by designer.

1. Sound Enhancement – Submit samples of audio visual cables provided including following components and characteristics:

a. Sample characteristics:

i. Provide all components in colors selected by Design consultant.

ii. Provide multiple samples where required to accurately represent range of cables to be provided.

D. The Contractor shall submit line drawings of all systems showing major components of the systems. Submit wiring diagrams showing connections for all systems and equipment.
E. Submit floor plan drawings clearly indicating all equipment and locations of equipment.
F. Quality Control Submittal

1. Test Reports: Submit complete sample test data and reports with exact labels used on cables and faceplates.

2. Certificates

a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.

b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in “Quality Assurance – Qualifications – Installer.”

G. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in “Operation and Maintenance Data” manual described in that Section.

1.5 QUALITY ASSURANCE

A. All Work shall be installed in a first class, neat and professional manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school district personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the school district is obtained.
B. Installer Qualifications: Qualified to cable, terminate and test cabling system specified in this Section, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.
C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal”, the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements:

1. Proposed product does not require extensive revisions to the Contract Documents.

2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.

3. Proposed product is fully documented and properly submitted.

4. Proposed product has received necessary approvals of authorities having jurisdiction.

5. Proposed product is compatible with AND has been coordinated with other portions of the Work.

6. Proposed product provides specified warranty.

7. If proposed product involves more than one contractor, proposed product has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

8. Submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

9. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.

10. Submission is accompanied with proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.6 WARRANTY

A. Installer’s Warranty: Provide manufacturer’s system warranty against electrical or mechanical defects for 1 year from date of final acceptance.

1. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

PART 2 - PRODUCTS

2.1 MATERIALS – ALL MATERIALS SHALL BE NEW AND UNUSED

A. Acceptable Products

1. The A/V Systems are based on Rane, Extron, Community, Biamp, Sennheiser, Shure, Lowell and other like reputable manufacturers.

a. Equipment substitutions must be submitted in writing to the design team for review and approval.

b. Any equipment not meeting the design criteria will be rejected at the contractor’s expense.

B. Dining A/V System

1. Equipment Cabinet

a. Middle Atlantic SR-40-32 Wall Mounted Swing Cabinet

2. Intercom Shunt

a. Bogen VAR1

3. A/V Projector

a. Epson Powerlite Pro G6750WUML with Lens.

b. Coordinate with exact screen.

c. Provide all mounts necessary.

4. A/V Switch

a. 8 port gigabit PoE switch

5. A/V Mixer

a. Extron IN1608

6. A/V Controller

a. Extron IPL 250

7. A/V Touch Panel

a. Extron TLP 350MV

8. A/V Extenders
    a. Extron DTP Series
9. A/V Faceplates
    a. Extron DTP Series
10. Mixer/DSP
    a. Biamp Tesira AI
11. Amplifier
    a. Crown XLS 1500
12. Assistive Listening
    a. Listen Technologies LS-54-072 Kit
13. Loudspeakers
    a. EV SX100
14. Wireless Mics
    a. Shure SLX124/85/sm58
15. DVD/CD Player
    a. Denon DN-300z
16. Auxiliary Input Switcher
    a. RDL EZ-HSX4
17. Power Conditioner
    a. Surge X SEQ 2 RU
18. Equipment Drawer
    a. Atlas SD4-14 Drawer
19. Mic Level Input
    a. Neutrik 1/4” XLR Combo
20. Line Level Input
    a. Neutrik Connector
21. Stereo Input
    a. Neutrik ¼” XLR Combo
22. Wired Microphone
    a. Shure SM58S
    b. Provide 3
23. Podium Microphone

a. Shure MX 412/C Gooseneck Podium Microphone

b. Provide 1

24. Microphone Stands

a. Atlas TEB-E

b. Provide 3

25. Wiring

a. Shielded Cat 5e or greater.

b. 18/2 AWG

c. XLR Microphone cable.

d. West Penn 226, or equal.

26. Miscellaneous Connectors

a. Provide Neutrik NC3 series “XLR”, Neutrik NP3C “TRS” or Canare F-09 “RCA” connectors.

b. Provide Switchcraft N112B connectors.

c. Provide crimped or gas-tight terminals for all loudspeaker connections. Wirenuts are not acceptable.

C. Gymnasium Sound System

1. Equipment Cabinet

a. Middle Atlantic SR-40-32 Wall Mounted Swing Cabinet

2. Intercom Shunt

a. Bogen VAR1

3. Mixer/DSP

a. Biamp Tesira AI

b. Biamp TEC-1S

4. A/V Switch

a. 8 Port gigabit PoE Switch

5. Amplifier

a. QSC RMS 1850 HD

6. Assistive Listening

a. Listen Technologies LS-54-072 Kit

7. Loudspeakers

a. EV SX100

8. Wireless Mics

a. Shure SLX124/85/sm58

9. DVD/CD Player
    a. Denon DN-300z
10. Auxiliary Input Switcher
    a. RDL EZ-HSX4
11. Power Conditioner
    a. Surge X SEQ 2 RU
12. Equipment Drawer
    a. Atlas SD4-14 Drawer
13. Mic Level Input
    a. Neutrik 1/4” XLR Combo
14. Line Level Input
    a. Neutrik Connector
15. Stereo Input
    a. Neutrik ¼” XLR Combo
16. Wired Microphone
    a. Shure SM58S
    b. Provide 3
17. Podium Microphone
    a. Shure MX 412/C Gooseneck Podium Microphone
    b. Provide 1
18. Microphone Stands
    a. Atlas TEB-E
    b. Provide 3
19. Wiring
    a. Shielded Cat 5e or greater.
    b. 18/2 AWG
    c. XLR Microphone cable.
    d. West Penn 226, or equal.
20. Miscellaneous Connectors
    a. Provide Neutrik NC3 series “XLR”, Neutrik NP3C “TRS” or Canare F-09 “RCA” connectors.

b. Provide Switchcraft N112B connectors.

c. Provide crimped or gas-tight terminals for all loudspeaker connections. Wirenuts are not acceptable.

D. Music/Rehearsal Sound System

1. Equipment Cabinet
    a. Middle Atlantic SR-40-32 Wall Mounted Swing Cabinet
2. Intercom Shunt
    a. Bogen VAR1
3. Mixer/DSP
    a. Biamp Tesira AI
    b. Biamp TEC-1S
4. A/V Switch
    a. 8 Port gigabit PoE Switch
5. Amplifier
    a. QSC RMX 1450 HD
6. Assistive Listening
    a. Listen Technologies LS-54-072 Kit
7. Loudspeakers
    a. EV Evid 3.6
8. Wireless Mics
    a. Shure SLX124/85/sm58
9. DVD/CD Player
    a. Denon DN-300z
10. Auxiliary Input Switcher
    a. RDL EZ-HSX4
11. Power Conditioner
    a. Surge X SEQ 2 RU
12. Equipment Drawer
    a. Atlas SD4-14 Drawer
13. Mic Level Input
    a. Neutrik 1/4” XLR Combo
14. Line Level Input
    a. Neutrik Connector

15. Stereo Input
    a. Neutrik ¼" XLR Combo
16. Wired Microphone
    a. Shure SM58S
    b. Provide 2
17. Ceiling Mic
    a. Shure Centaverse
18. Microphone Stands
    a. Atlas TEB-E
    b. Provide 2
19. Wiring
    a. Shielded Cat 5e or greater.
    b. 18/2 AWG
    c. XLR Microphone cable.
    d. West Penn 226, or equal.
20. Miscellaneous Connectors
    a. Provide Neutrik NC3 series "XLR", Neutrik NP3C "TRS" or Canare F-09 "RCA" connectors.
    b. Provide Switchcraft N112B connectors.
    c. Provide crimped or gas-tight terminals for all loudspeaker connections. Wirenuts are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which AV cabling and sound enhancement equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.
2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.

4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
5. Confirm all outlet locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.2 PREPARATION

A. Protection: Provide adequate protection of equipment and hardware before and after installation.
B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.
   1. Identify any additional outlets, circuits, and wiring at the site not shown on T-Drawings and interfering with installation of specified equipment.
   2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.3 CUTTING AND PATCHING

A. The contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.
B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.
C. When installing conduit, pipe or any other work in insulated concrete form (ICF) wall, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

3.4 INSTALLATION

A. Provide and install all components necessary to install complete AV cabling and sound enhancement equipment systems, including (but is not limited to) connectors, electronics, terminators, pass-thrus, cables etc…
   1. Velcro straps shall be used to loosely bundle cables. Zip Ties are not acceptable for use.
   2. Cable runs shall be factory terminated. Splicing of any cable is prohibited
   3. Secure all cables within ceiling cavities to building structure.
   4. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables where cable tray or other support structure has not been provided as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
   5. Do not violate manufacturer's recommended loadings. Leave 30% capacity for future use of pathway.
   6. Verify all horizontal cable run lengths prior to installation. Ensure cables do not exceed distances that would degrade the signal transmission requirements
   7. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch ceiling grid.
   8. Install cables in EMT in all unfinished or exposed areas

9. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.
10. Place cables in compliance with ANSI/TIA-568.C standards and BICSI recommended methods.
11. Tight 90-degree bends are unacceptable, and use of plastic "cinch-type" tie-wraps are not permitted, in order to prevent damage to cable jacket and compromise the cable's electrical or optical characteristics.
12. Communications outlets shall be located to be no more than 6 feet from an electrical outlet.

B. Determine allowable cable proximity to other electrical power sources of 480 Volts or less using TIA/EIA-569A "Cabling Pathway Standard" for UTP cable separations from sources of EMI:

1. Minimum separation distance from Power Source at 480 V or less:

CONDITION	< 2kVA	2-5 Kva	> 5 kVA
a. Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	6 in.	12 in.	24 in.
b. Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	3 in.	6 in.	12 in.
c. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway	3 in.	6 in.	12 in.
d. Transformers & Elec. Motors	40 in.	40 in.	40 in.
e. Fluorescent Lighting	12 in.	12 in.	12 in.

C. Install all cable in accordance with National, state and local codes and TIA/EIA Standards, and BICSI methods.

1. Follow manufacturer's guidelines and requirements for all cable termination.

D. Permanently identify all system components following ANSI/TIA-606A "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:

1. Identification: Provide permanent identification labels for outlets, faceplates and cables.
2. Each individual cable shall be labeled on both ends of cable terminations regardless of cable intended use. Labels must be machine printed with permanent black ink on laminated white label material. Contractors must check with appropriate school district personnel for appropriate labeling scheme. The intended format and labeling material must be approved by the school district Technology Department before labeling begins.

3.5 TESTING

A. Audio Visual Harness/Cabling

1. The contractor shall test all cables included in the harness for proper signal transmission based on manufacturer standards.
2. The contractor shall record remove any cable that does not meet manufacturer standards and replace it with a correctly functioning cable.

3. The contractor shall demonstrate that the installed cables meet manufacturer standards for signal transmission prior to the job being considered complete.

B. Sound Enhancement System

1. The contractor shall test all aspects of the sound enhancement amp/mixer once it is installed and demonstrate these functions to the owner of owner's representative.

    a. Speaker levels shall be verified to function individually and as a unit

    b. Microphones shall be demonstrated to work as intended by the manufacturer.

3.6 ACCEPTANCE

A. Contractors work shall be considered complete after the following conditions have been met:

1. Cable installation is complete and all cable runs have been tested and documented to be installed according to specifications and drawings.
2. Equipment installation is complete and all functions have been tested and documented to function as designed and per the manufacturer's recommendations.
3. All punch list items have been reconciled.
4. All disturbed ceiling panels, fire stopping materials, covers, etc. have been properly reinstalled.
5. All materials and trash have been removed from the site.
6. A 1-Year Installers warranty has been given to a school district Technology representative.
7. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 27 50 00 – INTERCOM AND CLOCKS

PART 1 - GENERAL

1.1 SUMMARYS

A. Section Includes
1. This section and associated drawings define a communications system for an intercom, public address and master clock system. The contractor shall provide all infrastructure, cable, hardware and equipment as defined to provide complete and operational systems.

1.2 SYSTEM DESCRIPTION

A. Design Requirements
1. Intercom/PA/Master Clock System
a. The facility intercommunication system shall be a low voltage system that utilizes a fiber and copper cable infrastructure to distribute a user-defined input in a single or bi-directional manner. The system shall be capable of multiple, simultaneous conversations on separate channels throughout the facility through telephones and loudspeaker assemblies.
b. A programmable master for tone distribution schedule shall also be included as part of the overall system.
c. The system shall be microprocessor based and have interconnection with the telephone system installed within the facility. In addition, the system must be expandable to meet the user's future expansion needs and be programmable from a computer terminal located at the facility.
d. The clock system shall consist of a master unit and slave clocks. All clocks shall be corrected wirelessly to the master clock system.

B. Performance Requirements
1. Rack/Cabinet mountable headend equipment.
2. Announcement distribution from a central location to zones, individual classrooms, groups or all facility speakers.
3. Broadcast of user defined input (radio signal, compact disc, aux input, etc.) to zones, individual rooms, groups or all facility loudspeakers.
4. Emergency cut-in to all speakers in an emergency situation from a central location.
5. Two-way intercommunication between the central rack, any call-in location or any selected two-way speaker location.
6. Hands free communications by means of a loudspeaker or speakerphone used as a transducer or speaker/microphone combination.
7. Visual and audio monitoring of all intercommunication system activity.
8. Volume and level controls for all centrally located intercommunication system equipment.
9. Tone distribution based off the master clock that can be partitioned into zones.
10. Capability to tie into any auxiliary sound system throughout the facility.
11. High priority call-in from any telephone/call switch in an emergency situation.

C. Regulatory requirements
1. All work will conform to the National Electric Code and applicable local ordinances.

1.3 SUBMITTALS

A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
   1. Submit the shop drawings, product data and quality control submittals specified below at the same time as the package
   2. Shop Drawings shall include the following items but are not limited to:
      a. Equipment and device quantities and types
      b. Wire types
      c. System wiring diagrams showing all connections
      d. Drawings including all equipment locations
      e. Associated equipment specifications and cut sheets
      f. Product data including catalog cut sheets, manufacturer's default specifications, user operation guides and a bill of materials

C. Quality Control Submittal
   1. Submit the name, address and telephone number of the nearest fully equipped service organization.
   2. Submit a certificate of completion of installation and service training from the system manufacturer.
   3. Certificates
      a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
      b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in "Quality Assurance – Qualifications – Installer."

D. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in "Operation and Maintenance Data" manual described in that Section.

1.4 AS-BUILTS

A. All systems must have as-built drawings provided in electronic CAD and hardcopy format that clearly show all system components, wiring schemes and system interconnections.

1.5 QUALITY ASSURANCE

A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the school systems is obtained.

B. Qualifications
   1. Installer
      a. Must be qualified to cable, terminate, install and program the equipment specified in this Section, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.

1.6 WARRANTY

A. Special Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for 1 year from date of final acceptance.

1. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support as well as additional application(s) introduced in the future by recognized standards or user forums
2. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

1.7 TRAINING

A. Installing contractor shall provide a minimum of 8 hours of training on system operation and managements as part of their scope of work.
   1. Additional hours shall be provided on a time and materials basis at the request of the owner.

B. Installing contractor shall provide a video recording on a standard format DVD to the owner which includes training sessions.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Installing contractor shall provide a minimum of two hardcopy and one electronic copy of all operation and maintenance manuals to the owner at project completion.

B. All passwords and software must be included for the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers
   1. The intercom and clock systems shall be manufactured by a reputable manufacturer with a proper support and maintenance operation in place.
      a. Intercom Basis of Design - Bogen
      b. Clock Basis of Design - Bogen

B. Substitute manufacturers
   1. Telecor
   2. Valcom

2.2 MATERIALS

A. CONSOLE
   1. Rack-mounted equipment shall be Bogen Model TCPER
      a. 77” Rack

B. MCRMP / MCMP / QRC24-48 (Compact Rack System)
   1. Rack Mount full, Mini-System, or Wall Mount panel. Shall include the following components:
      a. Quantum Processor Card QSPC1
      b. Analog Card
      c. Station Card
      d. Telephone Interface Card
      e. 5 volt / 12 volt Power Supply
      f. 26 volt Power Supply(s)
      g. Audio Program Module Interface Assembly

C. MCRMF / MCMF / QRC24-48

1. MCRMF Rack mounting mainframe. Includes built-in ventilation fans and the following circuit cards:
   a. Quantum Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card
   e. Ribbon Cable Assembly
2. MCF Wall Mount mounting mainframe. Utilizes convection cooling and the following circuit cards:
   a. Quantum Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card
3. QCR24 / QCR48 Compact Quantum Rack System Mainframe (1 per Mini-System). Includes built-in ventilation fan and the following circuit cards:
   a. Quantum Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card

D. MCRRP / MCRRC / MCRC
   1. Relay Module/Card

E. MCRCA
   1. Ribbon Cable Assemblies

F. Program Sources
   1. Tape Player & AM/FM Tuner
   2. 5-Disc CD Player
   3. AM/FM Tuner
   4. Desktop Paging Microphone

G. Power Amplifiers
   1. 60-Watt Amplifier
   2. 125-Watt Amplifier
   3. 250-Watt Amplifier

H. Station Equipment
   1. Administrative Display Phone
   2. Administrative VoIP Phone
   3. Administrative Wall-Mount Phone
   4. Administrative Desktop Phone
   5. Secure Call - Call Assurance Call-in Switch
   6. Call switch with Privacy
   7. Rocker-style Call Switch

I. Optional Equipment
   1. Telephone Access Card
   2. Telemedia Control Unit
   3. Television Control Unit
   4. Handheld Infrared Transmitter

J. Administrative Phone
   1. Admin phones shall be one of the following Bogen Model(s)

a. MCDS4 – Administrative Display Phone
b. QSIP1 – Administrative VoIP Phone (Desk or Wall)

K. Call Staff Stations
1. Staff Stations shall be Bogen Model:
a. SC1 – Secure Call - Call Assurance Call-in Switch
b. CA21B – Call Switch with Privacy

L. Call Staff Stations with volume controller
1. Staff Stations shall be Bogen Model:
a. SC1 – Secure Call - Call Assurance Call-in Switch
b. CA21B – Call Switch with Privacy
c. Bogen AT10A

M. Call Staff Stations with integrated speaker
1. Staff Stations shall be Bogen Model:
a. Rauland HSS14
b. Or approved equal

N. Intercom System Speakers
1. Classroom Speakers shall be Bogen:
a. Drop-in Ceiling Speakers: CSD2X2VR/U Drop-In Ceiling Speakers
b. Cut-in Ceiling Speakers: S86T725PG8U
c. Wall Speakers: MB8TSQ/SL Metal Box Speakers
2. Hallway Speakers shall be Bogen:
a. Ceiling Speakers: CSD2X2VR/U Drop-In Ceiling Speakers
b. Cut-in Ceiling Speakers: S86T725PG8U
c. Wall Speakers: MB8TSQ/SL Metal Box Speakers
3. Outdoor / Gym / Locker Room Speakers shall be Atlas Sound:
a. Atlas Sound VTF-157UCN or similar
4. Common Area Speakers shall be Bogen:
a. HFCS1 High-Fidelity Ceiling Speakers
b. OCS1 NEAR Orbit Ceiling Speakers
c. OPS1 NEAR Orbit Pendent Speakers

O. Master Clock
1. The system shall be Bogen BCMA 3000 Wireless Clock system.
2. The system shall provide for automatic clock correction for Daylight Savings Time, Spring Ahead/Fall Back. Daylight savings shall not require the use of any user input at the time of daylight savings.
3. The master clock system shall support a minimum of 16 schedules and 1536 events as outlined in the Intercom/PA Features section.
4. The system shall support Electronic Message Displays. These displays are integral to the emergency notification needs of the facility.
5. In the event of an Emergency Call from a classroom, the origin of the Emergency Call is displayed on multiple Electronic Message Displays, giving the opportunity for school staff to respond more quickly. In addition, a console or room telephone has the ability to activate a specific message for display on a group of EMDs. This allows an emergency procedure such as school “lock down” to be activated from any telephone, quickly and efficiently.

P. Clocks
1. Clocks shall be Bogen BCAL-2 120v powered, wirelessly corrected clocks in 12” and 16” surface, round with battery booster.

a. All clocks shall be corrected via RF.

Q. Accessories
1. Bogen 1000 Wireless Repeater.
2. Bogen Wireguard.

R. Corridor Clocks
1. Double faced Slave clock where indicated from Bogen

2.3 WIRING

A. Cable and Jacks
1. Headend to Call Switches shall be West Penn 25359B Plenum Rated Wire. Red/Black to speakers, Green/White to call switches.
2. PA Cable shall be plenum rated.
3. PA Cable shall be yellow or approved equal.
4. Hallway and exterior speaker runs shall utilize West Penn 25292B Plenum rated cable with no more than 10A per circuit.
5. PA Cable must be presented to the school district Maintenance and Electrical Department for approval prior to installation.

B. SPARE CAPACITY/SYSTEM EXPANSION
1. The contractor shall include extra circuits for staff telephones and loudspeakers built into the system for future expansion. Contractor shall provide and install fifteen percent (15%) extra circuitry (line cards, expanders, etc.) for these devices. The Owner shall add only field instruments (telephones and loudspeakers), cabling, and programming to make these extra capacity circuits fully operational.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which telecommunications cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.
2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.
4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
5. Confirm all device locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.2 PREPARATION

A. Protection: Provide adequate protection of equipment and hardware before and after installation.

B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.
   1. Identify any additional intercom equipment, devices, and wiring at the site not shown on T-Drawings and interfering with installation of specified equipment.
   2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.3 CUTTING AND PATCHING

A. The contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe or any other work in insulated concrete form (ICF) wall, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

3.4 INSTALLATION

A. Provide and install all components necessary to install complete intercom/PA/master clock system, including (but is not limited to) cable, connectors, patch panels, call switches, speakers, etc…

B. Secure all horizontal cables within ceiling cavities to building structure.
   1. Velcro straps shall be used to loosely bundle cables. Zip Ties are not acceptable for use
   2. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables (similar to Caddy Series “CableCat” or approved alternate mounting methods) including placement in cable tray as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
   3. Do not violate manufacturer’s recommended loadings. Leave 30% capacity for future use of pathway.
   4. Verify all horizontal cable run lengths prior to installation. Re-distribute horizontal cabling to maintain distance requirements and maintain pathway route accessibility.
   5. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings.
   6. Do not allow cables to touch ceiling grid.
   7. Install cables in EMT conduit in all unfinished, exposed areas as shown in Design consultant roof plans and/or T-Drawings, unless alternate pathways are noted.
   8. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.
   9. Place cables in compliance with ANSI/TIA-568.C standards and BICSI recommended methods.
   10. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing requirements. Replace any faulty cables/pairs or termination devices. Remove all defective cables completely from pathways.

C. Install all exposed cabling in surface raceway by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers' guidelines requirements regarding bending radius and slack. All bends, offsets and fittings shall be appropriately sized to provide 30% capacity after installation.

D. Install all cable in accordance with National, state and local codes and ANSI/TIA Standards, and BICSI methods.
   1. Follow manufacturer's guidelines and requirements for all cable termination.
   2. Follow detail drawings to locate equipment racks and cabinets. Where it is necessary to deviate, to obtain 30-inch clearance between equipment, obtain Design consultant's written approval before mounting cabinet/rack.
   3. Ladder-type cable tray shall be affixed 6 inches above all data racks and equipment cabinets, and routed to all points of entry into each telecommunications room.
      a. Include transition to proper height for penetration into hallway or other wall penetration as indicated on Drawings.
      b. Install sufficient 4-inch conduits from telecom rooms into hallway (minimum of 2) with protective insulating bushings, cable spillway or specially designed cable tray sections, with appropriate firestop materials.

E. Properly terminate all cables at speakers, call switches, administrative consoles and distribution racks. Permanently identify all cables in pullboxes, transition points, and termination points by affixing pre-marked self-adhesive wraps similar to Brady "B-500+ Plastic Cloth Markers."

F. Permanently identify all system components following ANSI/TIA-606A "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:
   1. Identification: Provide permanent identification labels for end devices and associated cabling at each end.

END OF SECTION

SECTION 28 10 00 - ACCESS CONTROL AND INTRUSION DETECTION

PART 1 GENERAL

1.1 REQUIREMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.2 SUMMARY

A. Provide a complete and fully operational Access Control System (ACS) and Intrusion Detection System (IDS) as described herein and the contract drawings.

B. The access control system and intrusion detection system shall be coordinated between installers providing door hardware, power sources and electronics.

C. Provide a Door Entry Video/Audio System complete with door controls, video monitors, intercom communications and expansion ports.

1.3 RELATED SECTIONS

A. Door Hardware (by others)

B. Electrical (by others)

1.4 SYSTEM DESCRIPTION

A. Design Requirements
   1. The Access Control system shall consist of the following:
      a) Communication Modules
      b) Door Controllers
      c) Access Control Card Readers
      d) Access Control Access Cards
   2. The Intrusion Detection System shall consist of the following
      a) Headend Panels
      b) Motion Detectors and Door Contacts
      c) Associated Cabling
      d) Communications Modules
   3. The Door Entry System shall consist of the following
      a) Video Intercom Stations
      b) Interior Handset Locations
      c) Door Controllers
      d) Door Locks
      e) Power Supply
      f) Cables.

B. Performance Requirements
   1. The ACS and IDS shall be controllable remotely and onsite to allow or prevent access to certain areas of the facility. Access shall be programmable by user type.
   2. Each end point shall be able to be monitored and controlled individually.
   3. The system shall produce a signal (both visual and audible) if the system is breached by an unauthorized user.
   4. The systems will be capable of communicating onsite as well as to remote locations.
   5. The systems shall be controllable in case of emergency situation.

6. The ACS and IDS shall be interfaced with the Fire Alarm system at the facility to allow egress in the case of a fire emergency.
7. Specific Exterior doors shall be equipped with Access Control equipment and Intrusion Detection Equipment.
8. Specific interior doors shall be equipped with Access Control Equipment and Intrusion Detection Equipment
9. The Access Control System must provide fail safe operation to disengage with a loss of power.
10. Specific locations shall have door contacts and motion detection as shown on the technology drawings
11. All equipment must be compatible with the existing owner equipment.
12. Request to Exit sensors shall be provided where required to allow of simple egress and alarm shunt.
13. The door entry system shall allow for visual two-way communications from a main entry door to the reception area. The system shall allow or disallow entry based on operator input. The system shall not interfere with other door hardware.

1.5 Code Requirements

1. Comply with applicable requirements in Local, State and Federal Codes, ANSI/TIA Standards, and BICSI methodology.
2. Specified cabling system derived from recommendations in approved telecommunications industry codes, standards and methods, including the following documents:
   a) Security Industry Association Methods and Standards
   b) ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
   c) ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
   d) ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
   e) ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
   f) ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
   g) ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
   h) ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
   i) ANSI-J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications
   j) ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard
   k) BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
   l) National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

1.6 SUBMITTALS

A. Product Data
   1. Shop Drawings with a detailed riser detail shall be provided. Device locations as well as cable paths will also be provided.
   2. Cut sheets with exact model of equipment and parts clearly highlighted for review by the design team. Failure to do so will result in an immediate rejection.

B. Quality Assurance/Controls Submittals
   1. Design Data for the system shall be submitted with the proposed submittals.
   2. Upon completion of the installation, test reports shall be submitted to verify that the system is fully operational and functioning properly.
   3. Certificates of designer and installer shall be submitted with job submittals.
   4. Manufacturer’s Instructions shall be followed and incorporated in the design of the system.

C. As-Builts
   1. As-Built drawings shall be supplied in AutoCad 2015 or later format and duplicate hardcopy format once the system has been installed completely.
   2. As-Builts shall include the attached Intrusion table filled out with the system configuration.

1.7 QUALITY ASSURANCE

A. A manufacturer's authorized distributor and installation contractor for the specified system shall install the security intrusion detection system. The installation shall include wiring, components, connections, adjustments, testing and certification. The Electrical Trade shall provide conduit, junction boxes and pull boxes as indicated and required by the security access control system manufacturer's drawings or trade instructions.

B. Regulatory Requirements
   1. All equipment and materials for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
   2. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.

C. The security intrusion detection system contractor shall furnish a list of similar or equal installations and demonstrate five (5) years certifiable experience in this type of work.

1.8 WARRANTY

A. The access control system and intrusion detection system shall be under warranty for a period of two (2) years upon the acceptance of the owner.

1.9 MAINTENANCE

A. This contractor shall coordinate with owner prior to bidding and award to determine the acceptable quantities of spare parts.

B. Upon the completion of the factory two (2) year warranty, a maintenance contract will be negotiated between the access control system trade and the owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ACS and IDS Basis of Design
   1. DSC
   2. Other Acceptable Manufacturers:
      a) Honeywell

B. Door Entry Basis of Design
   1. Aiphone

C. All components and equipment must be compatible with the entire system and be new and unused.

2.2 EQUIPMENT

A. The access control system basis-of-design manufacturer is DSC (Tyco Security Products), with Honeywell as an approved equal.
B. Bosch security products will not be specified.
C. ACS and IDS Parts
   1. DSC SD2002SA Software System Package
   2. DSC Maxsys PC4020 Control Panel

a) 16 zones on main control panel
b) Supports up to 16 hardwired keypads
c) Expandable up to 128 zones using hardwire, wireless modules and addressable zones
d) COMBUS hardwired expansion
e) 8 partitions
f) 1,500 user codes (4 or 6 digit)
g) 3,000-event buffer
h) 9 account and 3 phone numbers
i) 1 supervised bell zone
j) Built-in telephone line and siren supervision
k) Auto SIA and Contact ID formats
l) Supports GSM and T-Link™ alarm communicators
m) Full upload/download support with DLS download software
n) Approval Listings: European CE Directives (EMC, R&TTE, LVD), INCERT (Belgium), FCC/IC, UL/ULC

3. DSC T-Link Universal IP Alarm Communicator TL300
4. DSC 2-Reader Module PC4820
5. DSC Remote Equipment Cabinet PC4053
6. HID Prox Card Reader 5365

D. Access Cards
1. HID Smart ISOProx II Cards
2. Provide 200 cards

E. Zone Expansion Modules
1. PC4108/PC4116

F. TCP/IP Interface
1. T-Link TL300

G. Door Controller
1. PC4820

H. Recessed Door Contacts
1. Sentrol 1076D Double Pole Contact:
2. Normally closed, magnetic reed switch
3. 120 V, 500mA, and minimum of 100,000 operations

I. Panic Buttons
1. EOLR on the last device within a zone
2. Shall have the work Emergency printed on the fascia
3. Sentrol 3040

J. Motion Detectors
1. Dual technology PIR detectors
2. Wide Range
a) 90 degree pattern with look down
b) 30’ minimum range.
3. Long range
a) Minimum of 100’ distance
4. Overhead
a) 360 degree field of view
5. Provide Maxsys model or approved equal

K. Request to Exit Devices
1. T-REX

L. Keypads
1. LCD4501

M. Power Supplies

1. Altronix Power Supplies with Yuasa rechargeable batteries, appropriately sized.
   a) Transformers: NFPA 70, Class II control transformers, NRTL listed. Transformers for security access control system will not be shared with any other system.
2. Cabling:
   a) Acceptable manufacturers: Belden, Berk-Tek, Coleman, General Cable Technologies, Mohawk/CDT, and West Penn Wire/CDT.
   b) NFPA 70, Type CMP plenum rated per manufacturer's recommendations.
   c) Cabling is to be adequately sized for the installed distance to devices.
   d)

N. AIPHONES Parts
1. Main entrance video intercom and door release system is to be by Aiphone Corporation.
2. Master Station AIPHONE IS-IPMV
3. Sub Station AIPHONE IS-IPMV
4. Exterior Station IS-IPDVF
5. Control Unit AIPHONE IS-IPC
6. Expansion Unit AIPHONE IS-CCU
7. Selective door release adaptor RY-3DL.
8. 24 VDC power supply PS-2420UL.
9. Desk stand for video units MCW-2/A.
10. Chime extension speaker IER-2.
11. Cable:
    a) 14/2 AWG, 16/2 & 18/2 AWG minimum, plenum rated. Follow manufacturer guidelines.
    b) Cat 6 UTP

PART 3 EXECUTION

3.1 EXAMINATION

A. The access control and intrusion detection trade prior to installation of the systems shall verify site conditions.

3.2 CUTTING AND PATCHING

A. The contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe or any other work in insulated concrete form (ICF) wall, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

3.3 INSTALLATION

A. Velcro straps shall be used to loosely bundle cables. Zip Ties are not acceptable for use

B. This Contractor as directed by the equipment manufacturer shall make all low-voltage wiring and connections.

C. This Contractor shall label all access control and intrusion detection system junction boxes covers with the zone numbers contained therein.

D. This Contractor under the direct supervision of the Owner's technical staff shall perform the installation and final connections of all components and wiring.

E. All horizontal low voltage field-wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.

F. Devices
   1. All access control and intrusion system devices shall be installed as per the manufacture's installation guides.

G. Field Wiring
   1. All vertical low voltage field wiring shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings.
   2. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
   3. All horizontal low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in conduit. Conduit is not required in areas designated on the Drawings as Electric/Communications rooms or closets.
   4. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (5) feet on center.
   5. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.) wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
   6. This Contractor with insulated crimp wire connections shall make all low voltage wiring terminations. All low voltage field-wiring interconnections shall be made in junction boxes. All junction box covers shall be stenciled for distinct identification.
   7. All conduits, device mounting boxes, junction boxes, and line voltage wiring shall be furnished and installed by this Contractor.
   8. All wiring shall be checked and tested by this Contractor to insure the system is free from grounds, opens, and shorts.

3.4 ADJUSTING

A. Devices shall be adjusted and calibrated once system is operational to ensure proper and full functionality of the system.

3.5 Field Quality Control

A. General: Upon completion of the installation, System Trade's factory-trained technician shall perform all necessary electrical tests and adjustments and who shall then submit a Letter of Certification to the Owner/Architect/Engineer that the system functions and conforms to all requirements of the manufacturer of the equipment, these specifications, and all requirements of the building code for the type of building in which the system is installed.

B. Inspection
   1. The System Trade shall be responsible for all arrangements for testing and approval of the system before the system is accepted by the Owner and Architect/Engineer.

C. The factory-trained technician shall perform all electrical and mechanical tests, measurements and adjustments required below. All test costs shall be in the Contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate. The report shall include, but not be limited to:

1. A complete list of equipment installed and wired.
2. Indication that all equipment is properly installed and functions and conforms with these specifications.
3. Technician's name, certificate number and date.
4. The Intrusion Detection Device Table filled out accurately.

D. After completion of all tests, measurements and adjustments listed above, the System Trade shall submit the following information to the Architect/Engineer:
1. "As-built" conduit layout diagrams including wire color code and/or tag number.
2. Complete "as-built" wiring diagrams.
3. Complete operating and programming instructions, including engineering data sheets on each major component and complete servicing data including part numbers of the various components.

3.6 TESTING

A. Access and Intrusion Equipment
1. The contractor shall test all equipment for proper signal transmission based on manufacturer standards.
2. The contractor shall record remove any cable that does not meet manufacturer standards and replace it with a correctly functioning cable.
3. The contractor shall demonstrate that the installed cables meet manufacturer standards for signal transmission prior to the job being considered complete.

B. Devices and Equipment
1. The contractor shall test all aspects of the system once it is installed and demonstrate these functions to the owner of owner’s representative.
a) Devices shall be verified to function individually and as a unit
b) Devices shall be demonstrated to work as intended by the manufacturer.

3.7 PROGRAMMING

A. All aspects of the system shall be fully programmed and active for owner.
B. Integration with other systems shall be programmed.
C. Integration with owner equipment shall be programmed.
1. Coordinate all programming with the owner and owner’s equipment at the time of construction and installation.

3.8 AS-BUILTS

A. As-builts shall be provided by the contractor in hardcopy and electronic CAD format prior to project completion and inspection. PDFs inserted into CAD documents are not acceptable.
B. As-builts by contractor must include parts lists and wiring diagrams that clearly indicate all equipment, locations, wiring and connections.
C. Owner’s manuals shall be supplied as part of the as-built documentation.

3.9 DEMONSTRATION AND TRAINING

A. All aspects of the systems must be demonstrated for the owner at the time of training. A minimum of 8 hours of training shall be provided.
B. Training shall be video and audio recorder for the owner and turned over to the owner at acceptance.

3.10 ACCEPTANCE

A. Contractors work shall be considered complete after the following conditions have been met:
1. Cable installation is complete and all cable runs have been tested and documented to be installed according to specifications and drawings.
2. Equipment installation is complete and all functions have been tested and documented to function as designed and per the manufacturer’s recommendations.

3. All punch list items have been reconciled.
4. All disturbed ceiling panels, fire stopping materials, covers, etc. have been properly reinstalled.
5. All materials and trash have been removed from the site.
6. A 1-Year Installers warranty has been given to a school district Technology/Security representative.
7. Submit Manufacturer's Warranty Application.

Contact ID

ACCOUNT# Subscriber Name _____

CHOOSE ONE:

□ **ADDENDUM** TO A NEW SUBSCRIBER MONITORING AGREEMENT.
□ **CHANGE** TO DATA ON AN EXISTING SUBSCRIBER ACCOUNT.

NOTE: UNLESS OTHERWISE INDICATED, THE DEFAULT CALLBACK 0PTl0N FOR RESTORE IS **LOG ONLY**; **TROUBLE IS DEALER ONLY**.

FOR YOUR CONVENIENCE, PANEL PRINT OLITS ARE ACCEPTED. **HOWEVER**, PLEASE INDICATE CALLBACK OPTION. EXCLUSION OF THIS INFORMATION MAY DELAY THE PROCESSING OF A SUBSCRIBER MONITORING AGREEMENT. IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT YOUR SALES REPRESENTATIVE.

PANEL: □ADEMCO □NAPCO □ Maxsys □APEX OTHER (SPECIFY)_____
PARTITIONED?: □ NO □ YES (DEFINE BELOW)

1	5
2	6
3	7
4	8

EVENT QUAL.	EVENT CODE	PARTITION	ZONE# USER#	ZONE DESCRIPTION / USER NAME	CALLBACK OPTION	Ax

END OF SECTION

SECTION 28 23 00 - VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.01 REQUIREMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SUMMARY

A. Section includes a Video Surveillance System (CCTV) System as indicated on the T series drawings.
   1. Video surveillance cabling
   2. Video surveillance hardware, cameras and components
   3. Video Surveillance DVRs/NVRs
   4. Video Surveillance power supplies and ups equipment
   5. Video surveillance software and applications

1.03 REFERENCES

A. The complete installation, including additions and modifications, shall be in accordance with:
   1. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
   2. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
   3. ANSI/TIA-568-C.2: Balanced Twisted Pair Cabling and Components Standard
   4. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard
   5. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
   6. ANSI/TIA-570-B: Residential Telecommunications Cabling Standard
   7. ANSI/TIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
   8. ANSI-J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications
   9. ANSI/TIA-758-A: Customer-Owned Outside Plant Telecommunications Cabling Standard
   10. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
   11. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)
   12. National Electrical Code Article 800
   13. Security Industry Association (SIA) guidelines

1.04 SYSTEM DESCRIPTION

A. Design Requirements
   1. Provide a complete DVR base CCTV system
      a) The CCTV system shall have recorders connected to the local area network.
      b) DVR and power supply equipment shall be located in telecommunications spaces.
      c) The CCTV system shall be connected to UPS equipment and on facility emergency backup power.
      d) CCD cameras with indicated enclosure, mounts and domes.
      e) DVR network viewing of live & recorded video
      f) Lenses, automatic iris lenses and lens controls
      g) Rack type cabinets, cabling and miscellaneous materials as required and specified herein, and in accordance with the applicable codes
   2. The CCTV system shall be designed to accommodate a 70+ camera system. Parts listed within this specification shall remain the same for the system; however, quantities of parts

may change to correspond to the number of cameras. Refer to contract drawings for exact quantities of devices and locations.

B. Performance Requirements
1. The CCTV System shall have the capability of real-time recording, viewing and playback simultaneously.
2. Real-time video searching.
3. Time and Data stamp
4. PTZ control from a keyboard or via remote software.
5. Video archiving
6. Day/Night recording capabilities
7. H.264 compression
8. Multiple frame rate recording from 1fps to 30 fps.
9. Access to the system via IP communications on the district LAN and WAN.
10. Multiple DVR units function as virtual unit.

1.05 SUBMITTALS

A. Shop Drawings
1. The CCTV System contractor shall provide a one-line riser diagram indicating camera location, mounting type, cable type and length, cable route and conduit size and connections of system proposed.
2. Furnish complete operating instructions, including schematic and wiring diagrams of the system, engineering data sheets on each component and complete servicing data including part numbers of the various components
3. Locate all components on shop drawings and As-Builts

B. Equipment Cut Sheets

1. All equipment must be clearly labeled with exact quantities and parts specified for use on the job. Any equipment not clearly called out in product data submittals will be rejected without question and must be resubmitted at no cost to the owner.

C. As-Built Drawings
1. As-Built drawings shall be submitted in AutoCad 2015 or later electronic format and duplicate hardcopy format when the system has been completely installed. Drawings shall indicate all wiring and connections.
2. As-Builts shall include O&M manuals, cut sheets and manuals.
3. Provide 3 copies electronically and in hardcopy

1.06 QUALITY ASSURANCE

A. Source Quality Control - Materials and equipment shall be new, unused and UL listed.

B. The system and components shall be supplied by one manufacturer of established reputation and experience who shall have produced similar apparatus far a period of five (5) years and who shall be able to refer to similar installations rendering satisfactory service.

C. The manufacturer’s authorized distributor and installation contractor for the specified systems, hereinafter known as the “CCTV System Trade”, shall install the CCTV Systems.

D. The installation shall include wiring, components, connections, adjustment, testing and certification. The Electrical Trade shall provide conduit, junction boxes and pull boxes as indicated, and required by the CCTV System manufacturer's drawings or Trade instructions. The CCTV Trade shall furnish any special boxes, cabinets, enclosures and similar items to the

Electrical Trade for installation by the Electrical Trade in accordance with the manufacturer's drawings, Trade instructions, and as indicated on Drawings.

E. The CCTV System Trade shall furnish a list of similar or equal installations and demonstrate five (5) years certifiable experience in this type of work.

1.07 WARRANTY

A. The CCTV System manufacturer and Trade shall warrant the CCTV Systems for a minimum of two (2) years from date of acceptance by Owner against defective parts and/or workmanship and shall provide parts and labor to fulfill this warranty at no cost to Owner

B. Qualified service and parts shall be available to call on within a 150 mile basis

C. The CCTV System Trade shall include in his quotation the cost of three (3) inspections of the system during the two (2) year subsequent to the installation The Trade installing this equipment shall be prepared to offer the Owner a service contract after the guarantee period has ended On-the-premises service furnished at other than normal working hours shall also be available and shall be charged at current labor rates Sub-letting of this service shall disqualify the bidder.

1.08 COMMISSIONING

A. Final tests and inspection shall be held in the presence of the owner and to their satisfaction The CCTV System Trade shall supply personnel and required auxiliary equipment for this test without additional cost.

B. The completed CCTV Systems shall be tested to insure that it is operating properly. Acceptance of the systems shall also require a demonstration of the stability of the systems. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any problems. Should a problem occur, the System Trade shall readjust or replace the defective components and begin another ninety (90) day test period. This test shall not start until the Owner has obtained beneficial use of the building under tests.

C. If the requirements provided in the paragraph above are not completed within one (1) year after beginning the tests described therein, the CCTV System Trade shall replace either or both systems with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Architect/Engineer.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General
   1. All materials, equipment, accessories, devices and other facilities for the CCTV Systems shall be new, best suited for its intended use and shall conform to applicable and recognized standards for their use. All equipment shall be the standard cataloged products of the manufacturers shown.

B. The video surveillance system basis-of-design is General Electric (GE) Security (United Technologies Company, UTC Fire & Security), that is compatible with the existing GE Security software.

C. Application Software: GE-NAV v4, or higher.

D. Recording Equipment (Network Video Recorders): TruVision 32 channel Network Video Recorder (NVR) by GE Security/UTC Fire & Security.

E. Switching Equipment: General Electric: GE 24 port 1000+4 GigE SFP POE stackable managed switch (part number GE-DSSG-244-POE) with GE S30-2MLC fiber module.

F. Video Cameras:
   1. Interior Fixed Camera: UTC TVD 3103
   2. Interior 360° Camera: UTC TVF-3103
   3. Exterior Fixed Camera: UTC TVD 3104
   4. Exterior 360° Camera: UTC TVP 3104

G. Power Supplies:
   1. Altronix
   2. Or approved equal, with Yuasa rechargeable batteries.

H. Cabling:
   1. Acceptable manufacturers: Belden, Berk-Tek, Coleman, General Cable Technologies, Mohawk/CDT, and West Penn Wire/CDT.
   2. NFPA 70, Type CMP plenum rated per manufacturer's recommendations.
   3. Unshielded twisted pair (UTP) camera cabling: Category 6, plenum rated.
   4. Cabling is to be adequately sized for the installed distance to devices.
   5. Fiber – OM4 50 Micron Multi Strand Fiber

I. Rack Mount Monitor and Keyboard
   1. APC LCD KVM Console (19”)

J. UPS
   1. APC 3000 VAC 120v Smart UPS online

K. Accessories:
   1. Bosch D166 telephone jack, Bosch D5215 memory expansion board.
   2. Surge protection: DITEK Corporation, or approved equal.
   3. Uninterruptible power supply (UPS) for recording equipment: APC, or approved equal.
   4. Cat 6 UTP Patch Panels
   5. Fiber Housing with 6-Pack Connectors

PART 3 EXECUTION

3.01 INSTALLATION

A. General
   1. Provide the CCTV System with all wire, cables, conduit, outlets and equipment as on the drawings and as specified herein.
   2. All material and/or equipment necessary for the complete and proper operation of the system, even though not specifically mentioned in the Contract Documents, shall be deemed part of this Contract.
   3. All equipment shall be installed and connected in strict accordance with the manufacturer's recommended instructions so as to provide for matched systems for service maintenance from one source, all equipment shall be furnished by one equipment supplier except where indicated

B. Wiring
   1. Complete Conduit Raceway System All wiring methods shall be in accordance with NFPA-70, Article 800, and all other codes specified herein Provide proper number, size of wires and conduit as required for operation of the system in accordance with the manufacturer's instructions. All wiring methods on the system's load side shall be shielded power limited type in conduit as specified in NEC Article 800
   2. No wiring other than that directly associated with the system shall be permitted in these conduits.
   3. Wiring splices are to be avoided to the extent possible, and if needed they must be made only in junction boxes and shall be crimp connected Wire nut-type connections are not acceptable on low voltage control
   4. Transposing or changing color coding of wires shall not be permitted

5. All conductors shall be labeled on each end with "E-Z markers" or equivalent
6. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its termination
7. Cabinet terminals shall be numbered and coded All controls, function switches, etc, shall be clearly labeled on all equipment panels
8. All power connections to racks, cameras, devices and equipment shall be made with crimp-type terminal connections, or resin core solder method approved by manufacturer.
9. All coaxial cable (RG-59 and RG-6) connections shall be made with BNC connectors.
10. All wiring shall be checked and tested to insure that there are no grounds, opens or shorts.
11. Coaxial line shields are to be grounded only at the camera connector and at the video input module connectors. Shields on cables between accessory items of equipment are to be grounded at one end only. All cable shields are to be insulated at the "floating" end. Continuity of shield is to be preserved at all connecting points.
12. All audio grounds in any equipment rack, as well as the racks themselves, are to be earth grounded certain coaxial cables shall require cable "isolation transformers" to prevent ground looping.
13. All wiring shall be executed in strict adherence to standard practices Camera coaxial cables and 24 volts AC, and remote wiring to be installed in separate conduits All conduits shall be well spaced from power conduits, and shall be properly grounded to the building grounding electrode system ground Lines in conduit are not to be spliced.
14. All boxes, conduits, etc., shall be of proper size, as determined by the CCTV Systems Trade, shall be clearly marked for easy identification, and continuously grounded together.
15. All equipment except portable equipment shall be firmly held in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. All exterior hardware shall be proper stainless steel or hot-dipped galvanized unless aluminum is encountered.
16. The CCTV System Trade shall take such precautions as are necessary to prevent and guard against E M I, supply adequate ventilation, and to install the equipment so as to provide reasonable safety for the operator.
17. The actual circuit routing of the CCTV System shall be by the installing trade based on the location of the devices, circuit limitations and wire limitations.
18. All co-axial cable, control wiring and power wiring to exterior camera locations shall have surge or transient protectors as required by U L, NEC, EIA, ANSI, TIA and the manufacturers.
19. Velcro straps shall be used to loosely bundle cables. Zip Ties are not acceptable for use

C. Cabinet Equipment Location
1. The video monitors, multiplexers, multiplexer servers and DVR's shall be installed in the CCTV racks.
2. The camera power supplies shall be mounted in the top of the rack to avoid overheating and conflicts in the cabinet.

3.02 CUTTING AND PATCHING

A. The contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe or any other work in insulated concrete form (ICF) wall, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid

insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

D.

3.03 FIELD QUALITY CONTROL

A. General: Upon completion of the installation, the CCTV System Trade's factory-trained technician shall perform all necessary electrical tests and adjustments and who shall then submit a Letter of Certification to the Owner/Architect/Engineer that the system functions and conforms to all requirements of the manufacturer of the equipment, these specifications, and all requirements of the building code for the type of building in which the system is installed.

B. Inspection
   1. The CCTV System Trade shall be responsible for all arrangements for testing and approval of the system before the system is accepted by the Owner and Architect/Engineer.

C. The factory-trained technician shall perform all electrical and mechanical tests, measurements and adjustments required below. All test costs shall be in the Contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate. The report shall include, but not be limited to:
   1. A complete list of equipment installed and wired.
   2. Indication that all equipment is properly installed and functions and conforms to these specifications.
   3. Technician's name, certificate number and date.

D. After completion of all tests, measurements and adjustments listed above, the CCTV System Trade shall submit the following information to the Architect/Engineer:
   1. "As-built" conduit layout diagrams including wire color code and/or tag number.
   2. Complete "as-built" wiring diagrams.
   3. Complete operating and programming instructions, including engineering data sheets on each major component and complete servicing data including part numbers of the various components.

3.04 TESTING

A. CCTV Equipment
   1. The contractor shall test all equipment for proper signal transmission based on manufacturer standards.
   2. The contractor shall record remove any cable that does not meet manufacturer standards and replace it with a correctly functioning cable.
   3. The contractor shall demonstrate that the installed cables meet manufacturer standards for signal transmission prior to the job being considered complete.

B. Devices and Equipment
   1. The contractor shall test all aspects of the system once it is installed and demonstrate these functions to the owner of owner’s representative.
      a) Devices shall be verified to function individually and as a unit
      b) Devices shall be demonstrated to work as intended by the manufacturer.

3.05 PROGRAMMING

A. All aspects of the system shall be fully programmed and active for owner.
B. Integration with other systems shall be programmed.
C. Integration with owner equipment shall be programmed.
   1. Coordinate all programming with the owner and owner’s equipment at the time of construction and installation.

3.06 AS-BUILTS

A. As-builts shall be provided by the contractor in hardcopy and electronic CAD format prior to project completion and inspection. PDFs inserted into CAD documents are not acceptable.
B. As-builts by contractor must include parts lists and wiring diagrams that clearly indicate all equipment, locations, wiring and connections.
C. Owner's manuals shall be supplied as part of the as-built documentation.

3.07 DEMONSTRATION AND TRAINING

A. All aspects of the systems must be demonstrated for the owner at the time of training. A minimum of 16 hours of training shall be provided.
B. Training shall be video and audio recorder for the owner and turned over to the owner at acceptance.

3.08 ACCEPTANCE

A. Contractors work shall be considered complete after the following conditions have been met:
    1. Cable installation is complete and all cable runs have been tested and documented to be installed according to specifications and drawings.
    2. Equipment installation is complete and all functions have been tested and documented to function as designed and per the manufacturer's recommendations.
    3. All punch list items have been reconciled.
    4. All disturbed ceiling panels, fire stopping materials, covers, etc. have been properly reinstalled.
    5. All materials and trash have been removed from the site.
    6. A 1-Year Installers warranty has been given to a school district Technology/Security representative.
    7. Submit Manufacturer's Warranty Application.

END OF SECTION

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Firefighters' two-way telephone communication service.
7. Magnetic door holders.
8. Graphic annunciator.
9. Addressable interface device.
10. Digital alarm communicator transmitter.
11. System printer.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.6 ACTION SUBMITTALS

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

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector

housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level III minimum.
c. Licensed or certified by authorities having jurisdiction.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, deliver copies to authorities having jurisdiction and include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
a. Frequency of testing of installed components.
b. Frequency of inspection of installed components.
c. Requirements and recommendations related to results of maintenance.
d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

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

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. NOTIFIER; a Honeywell company.
   2. Siemens Building Technologies, Inc.; Fire Safety Division.
   3. SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   1. Manual stations.
   2. Heat detectors.
   3. Flame detectors.
   4. Smoke detectors.
   5. Duct smoke detectors.
   6. Verified automatic alarm operation of smoke detectors.
   7. Automatic sprinkler system water flow.
   8. Heat detectors in elevator shaft and pit.
   9. Fire-extinguishing system operation.
   10. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm at fire-alarm control unit and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke doors held open by magnetic door holders.
   6. Activate voice/alarm communication system.
   7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
   9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   10. Recall elevators to primary or alternate recall floors.
   11. Activate emergency shutoffs for gas and fuel supplies.
   12. Record events in the system memory.
   13. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. Low-air-pressure switch of a dry-pipe sprinkler system.
   3. Elevator shunt-trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of primary power at fire-alarm control unit.
   4. Ground or a single break in fire-alarm control unit internal circuits.
   5. Abnormal ac voltage at fire-alarm control unit.
   6. Break in standby battery circuitry.
   7. Failure of battery charging.
   8. Abnormal position of any switch at fire-alarm control unit or annunciator.
   9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
   10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
      a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
      b. Include a real-time clock for time annotation of events on the event recorder and printer.
   2. Addressable initiation devices that communicate device identity and status.
      a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
      b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
   3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, 2 line(s) of 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:
   1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
      a. Initiating Device Circuits: Style D.
      b. Notification Appliance Circuits: Style Z.
      c. Signaling Line Circuits: Style 6.
      d. Install no more than 50 addressable devices on each signaling line circuit.

2. Serial Interfaces: Two RS-232 ports for printers.

D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Elevator Recall:
1. Smoke detectors at the following locations shall initiate automatic elevator recall
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
   a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear."
   d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
   1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
   1. Batteries: Sealed lead calcium].

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   2. Station Reset: Key- or wrench-operated switch.
   3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
   4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Detectors shall be four-wire type.
   3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
   6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
      a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.

b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.

B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
1. Rated Light Output:
a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

C. Voice/Tone Notification Appliances:
1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. Low-Range Units: Rated 1 to 2 W.
3. Mounting: Flush.
4. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.8 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
1. Common-talk type for firefighter use only.
2. Selective-talk type for use by firefighters and fire wardens.
3. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
4. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash.
5. Selector panel controls shall provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
6. Display: Graphic to indicate location of caller.
7. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
b. With "break-glass" type door access lock.
8. Handsets: push-to-talk-type sets with noise-canceling microphone stored in a cabinet.

2.9 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.10 GRAPHIC ANNUNCIATOR

A. Graphic Annunciator Panel: Mounted in an aluminum frame with non-glare, minimum 3/16-inch-thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.
1. Comply with UL 864.

2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Semi-flush mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot scale or larger.
6. The LED representing a detector shall flash two times per second while detector is an alarm.

2.11 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
1. Address of the alarm-initiating device.
2. Addressof the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 SYSTEM PRINTER

A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.14 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Factory fabricated and furnished by manufacturer of device.
   2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in the International Building Code.

C. Smoke- or Heat-Detector Spacing:
   1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
   2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
   3. Smooth ceiling spacing shall not exceed 30 feet.
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
   5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in other sections. Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
6. Supervisory connections at valve supervisory switches.
7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
8. Supervisory connections at elevator shunt trip breaker.
9. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in other sections.

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
1. Visual Inspection: Conduct visual inspection prior to testing.
a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 31 10 00 – SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 SUMMARY

A. This Section includes the following:

1. Protection of existing trees indicated to remain.
2. Removal of trees and other vegetation.
3. Topsoil stripping.
4. Clearing and grubbing.
5. Removal and disposal of pavement areas, inclusive of pavement base courses, sidewalk, curb, and combination curb and gutter.
6. Removal of above-grade improvements pertains to those shown on the drawings and all those existing improvements readily visible at the site and in the drawings which interfere with the work.
7. Removing below-grade improvements pertains to those items shown on the drawings, and those associated with the above grade improvements to be removed, if they impede the proposed work.
8. Removal and/or abandonment of utilities and appurtenances.

1.3 PROJECT CONDITIONS

A. Traffic: Conduct site-clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction. The Contactor shall provide Maintenance of Traffic (MOT) in accordance with the requirements of Baltimore City Department of Public Works.

B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

1. Protect improvement on adjoining properties and on Owner's property.
2. Restore damaged improvements to their original condition, as acceptable to property owners.

C. Soil Erosion and Sediment Control: Soil erosion and sediment control measures are required for this site in accordance with the approved plans. Soil erosion and sediment control measures disturbed or

damaged by clearing operations shall be restored to operating condition in accordance with the requirements of the approved plan before the end of the work day.

D. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bar, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.

1. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
2. Provide protection for roots over 1-1/2 inch in diameter that are cut during construction operations. Coat cut faces with emulsified asphalt or other acceptable coating formulated to use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out, cover with earth as soon as possible.
3. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations in manner acceptable to Architect. Employ a licensed arborist to repair damage to trees and shrubs.
4. Replace trees that cannot be replaced and restored to full-growth status, as determined by arborist.

E. Improvements on Adjoining Property: Authority for performing removal and alteration work on property adjoining Owner's property will be obtained by Owner prior to award of contract.

1. Extent of work on adjacent property is indicated on Drawings.

F. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated or directed. Refer to Division 01 Section "Construction Waste Management and Disposal."

1.4 EXISTING SERVICES

A. General: Indicated locations are approximate, determine exact locations before commencing Work.

B. Arrange and pay for disconnecting, removing, capping, and plugging, utility services. Notify affected utility companies in advance and obtain approval before starting this Work.

C. Place markers to indicated location of disconnected services. Identify service lines and capping locations on Project Record Documents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SITE CLEARING

A. The contractor shall prepare and submit a demolition/construction staging plan to Baltimore City Public Schools for approval prior to beginning any construction. Refer to Division 01 Section "Construction Waste Management and Disposal."

B. General: Remove trees, shrubs, grass, and other vegetation, improvements, or obstructions, as required, to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. Removal includes digging out and off-site disposal of stumps and roots.

1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

C. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 1/2 inches in diameter, and without weeds, roots, and other objectionable material.

1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.

a. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.

2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.

3. The thick organic plow layers that are to be stripped generally consist of sandy soils and are expect to be suitable for reuse in the athletic field areas.

4. Dispose of unsuitable or excess topsoil as specified for disposal of waste material.

D. Clearing and Grubbing: Clear site of trees, shrubs, and other vegetation, except for those indicated to be left standing.

1. Completely remove stumps, roots, and other debris protruding through ground surface.

2. Use only hand methods for grubbing inside drip line of trees indicated to remain.

3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

a. Place fill material in horizontal layers not exceeding 8 inches loose depth, and thoroughly compact each layer to a density not less than 92 percent of the maximum dry density when tested in accordance with AASHTO T180.

E. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.

1. Removal of pavement, including base courses, sidewalk, curb, and combination curb and gutter, shall be for the full depth thereof.

2. Existing foundations shall be removed in their entirety.

3. The Contractor shall use suitable equipment, tools, and methods for cutting and trimming as well as removing the materials to the neat lines set by the Owner and shall not in any manner disturb or damage the sections of base or pavement to be salvaged.

4. Damage done by the Contractor's equipment or methods to those areas designated for salvaging shall be replaced at the Contractor's expense.

5. Where the old subgrade is satisfactory as to condition and elevation, special care shall be taken in the removal operation in order to avoid the disturbing of the old grade.

6. Abandonment or removal of certain underground pipe or conduits may be indicated on mechanical or electrical drawings and is included under work of related Division 22 and 26 Sections. Removing abandoned underground piping or conduits interfering with construction shall be as follows:

   a. Underground improvements shall be completely removed to a depth of two feet below indicated subgrade under structures and paving or finished grade in other areas or where it conflicts with proposed construction.

   b. Pipes and other utilities indicated to be abandoned in place shall have open ends plugged with concrete for a minimum length of one foot. Structures, manholes, and other utility appurtenances shall be filled with compacted subgrade materials.

7. Fill depressions caused by clearing and grubbing and removal of improvements with satisfactory material, unless further excavation or earthwork is indicated.

3.2 DISPOSITION OF UTILITIES

A. Verify with the Authority having jurisdiction that utility lines indicated to be removed or abandoned are no longer in service before beginning removal or abandonment.

B. Relocation of Utilities: Where utility services (which include water, sewer, storm drains, electrical, gas, telephone, etc.) Are to be relocated as a part of the work of this contract, the Contractor shall maintain the existing utility services in service until the relocate services have been completed and approved. The Contractor shall coordinate with the Authority having jurisdiction to make temporary service connections, re-route services and make tie-ins all as may be required.

C. Unknown Utilities: Where utilities are encountered in the work, the presence of which is not shown or indicated on the drawings, the Contractor shall immediately notify the Authority having jurisdiction. The Contractor shall immediately notify the Authority having jurisdiction and maintain these unknown utility services until instructed by the Authority having jurisdiction as to the proper disposition of the utility.

3.3 DISPOSAL OF WASTE MATERIALS

A. Burning on Owner's Property: Burning is not permitted on Owner's property.

B. Removal from Owner's Property: Remove waste materials and unsuitable or excess topsoil from

Owner's property and dispose of off-site in accordance with local regulations.

3.4 RECORD DRAWINGS

A. Survey and include on record drawings location and depth of all utilities encountered which have not been removed.

END OF SECTION

SECTION 31 23 00 – EXCAVATING AND FILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 DESCRIPTION

A. This Section includes the following:

1. Backfilling operation to bring the existing site to grade.
2. Preparing and grading sub grades to slabs-on-grade, walks, pavements, and landscaping.
3. Excavating and backfilling for buildings and structures.
4. Drainage and moisture -control fill course for slabs-on-grade.
5. Subbase course for walks and pavements.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches within building lines.
8. Excavating and backfilling for underground utilities and appurtenances.

B. Related Sections:

1. Section 311000: Site Clearing
2. Section 329300: Planting
3. Section 033300: Cast-in-Place Concrete

1.3 DEFINITIONS

A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

C. Borrow: Soil material off-site when sufficient approved soil material is not available from on-site excavations.

D. Subbase Course: The layer between the subgrade and base course in a paving system or the layer placed between the subgrade and surface of a pavement or walk.

E. Base Course: The layer placed between the subbase and surface pavement in a paving system.

F. Drainage Fill: Course of washed granular material supporting slab-on-grade placed to cut off upward capillary flow of pore water.

G. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.

H. Additional excavation: When excavation has reached required subgrade elevations, notify the Inspection Agency, who will make an inspection of conditions. The Contractor is responsible for scheduling the inspections such that there is no delay in the Project. If the Inspection Agency determines that bearing material at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by them.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

J. Utilities include on-site underground pipes, conduits, ducts, and cable, as well as underground services within building lines.

K. Rock Excavation in Trench Excavation and Pits, including continuous wall footings and individual column footings, shall consist of:

1. The removal of/and disposal of solid rock, ledge rock, rock hard cementitious materials and/or boulders ½ cubic yards or more in volume in trench excavations less than 10 feet in width and pits less than 30 feet in either length or width.

2. Excavation of materials that required the use of:
   a) Excavating equipment which exceeds standard Earth Excavating Equipment as defined herein.
   b) Systematic drilling.
   c) Hand-held or backhoe mounted pneumatic hammers
   d) Blasting.

3. Blasting will only be permitted after receiving permission from the owner and local authorities. The Contractor shall obtain special liability insurance to protect all parties, including the Owner and Engineers from all claims resulting from any blasting.

L. Rock Excavation in open excavation (all excavations other than trench excavation and pit excavation) shall consist of the following:

1. The removal and disposal of solid rock, ledge rock, rock hard cementitious material and/or boulders 2 cubic yards or more in volume.
2. Excavation of materials that requires the use of:

   a. Excavation equipment which exceeds standard Earth Excavation Equipment as defined herein.
   b. Systematic drilling.
   c. Hand-held or backhoe mounted pneumatic hammers.

d. Blasting.

3. Blasting will only be permitted after receiving permission from the owner and local authorities. The Contractor shall obtain special liability insurance to protect all parties, including the Owner and Engineers from all claims resulting from any blasting.

M. The Contractor is advised that minimum standard earth excavation equipment is defined as follows:

1. For Trench Excavation as defined herein: 250 H.P., track mounted, hydraulic excavator with a 3-foot rock bucket.
2. For Open Excavation as defined herein: 280 H.P. crawler dozer with a single shank ripper.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for the following:

1. Each type of warning tape.
2. Filter fabric.

C. LEED Submittals:

1. Product Data for Credit MR 4: For recycled content materials, documentation indicating percentages of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
2. Product Data for Credit MR 5: For regional materials, documentation indicating location of manufacture and location of extraction or recovery of primary raw materials. Include statement indicating cost of each product with regional material content.

D. Test Reports: In addition to test reports required under field quality control, submit the following:

1. Laboratory analysis of each soil material proposed for fill and backfill from on-site and borrow sources, including classification per ASTM D2487.
2. One moisture density curve for each soil material, per AASHTO T-180.
3. Reports of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of Authorities having jurisdiction.

B. Testing and Inspection Service: The Owner will engage a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing during earthwork operations and to check bearing capacities of excavated footings to confirm required bearing capacity prior to installation of reinforcing steel and concrete.

1.6 PROJECT CONDITIONS

A. Backfilling below-grade areas: The backfilling operation required to bring actual grades to the grade elevations shown on the drawings as existing grades.

1. The borrow material shall be removed and then either stored or disposed. If the testing agency verifies that the borrow material complies with these specifications for backfill material, then the Contractor may use it to backfill this area to grade.
2. Any additional backfill material necessary to complete this operation shall comply with these specifications.
3. This backfilling operation shall be the first earthwork operation performed on site after establishment of the sediment control devices.

B. Site Information: Data in subsurface investigation reports was used for the basis of the design. The data in the subsurface investigation report is not a part of the Contract. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. The Owner, Architect or Engineers will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1. Additional test borings and other exploratory operations may be performed by the Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided. If existing utilities are indicated to be abandoned, the Contractor shall remove such utility, if necessary, at no additional cost to the Owner.

1. Provide a minimum 48-hours notice to the Architect and receive written notice to proceed before interrupting any utility.

D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shutoff services if lines are active.

E. Should uncharted or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

F. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Open excavation within the roadways shall be plated and shall be posted with warning devices in accordance with the Manual of Uniform Traffic Control Devices.

1. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.
2. Work which affects the public right-of-way shall be in accordance with the Baltimore City requirements and regulations.

G. Moisture Sensitive Soils:

1. The on-site founding materials are moisture sensitive and will be easily disturbed by excessive construction activity.
2. The exposed founding materials shall be protected against detrimental changes in engineering qualities as a result of disturbance from rain or frost.
3. Surface runoff shall be drained away from the excavations and not allowed to pond.
4. If possible, concrete shall be placed in the footings the same day the excavations are made, or the founding materials may be covered by mud mats in order to protect the founding soil from becoming saturated due to forecasted precipitation and/or disturbed due to excessive construction activity during the placement of steel reinforcement.
5. The presence of moisture sensitive fine-grained soils poses the potential for high moisture content. Soils may be found to be at or near their plastic limit; consequently, the on-site soils may require discing, aeration, and/or manipulation to achieve efficient compaction.
6. Any regions exhibiting poor drainage characteristics, and low lying areas, shall be expected to display moisture contents which are excessively high for normal earthwork operations.
7. Any standing water shall be drained or pumped into approved sediment control facilities prior to commencement of earthwork.
8. Excavations near to subgrade and all fills should be protected from traffic of heavy equipment, including heavy compaction equipment, when on-site soils exhibit high moisture contents, in order to minimize pumping and a generalized deterioration of these materials.

H. The Contractor is solely responsible for the protection of the sub-grade until it receives final surface treatment and shall maintain the sub-grade as suitable and acceptable to the Owner or Owner's Representative at all times. He shall be completely responsible for restoration or replacement of the sub-grade due to moisture damage, construction traffic, or any other cause. Repair or replacement of the sub-grade shall be performed at no additional cost to the Owner.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations. Classification of materials shall be made by the Owners independent testing agency.

1. Provide subbase and backfill manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

B. Satisfactory Soil Materials: ASTM D 2487 soil classified as ML or more granular and should have a liquid limit less than 40 and a plasticity index less than 20; free of rock or gravel large than 4 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter. However, materials used as backfill behind below grade walls or retaining walls should have classifications of SM, or more granular, in accordance with ASTM D 2487, and should have no more than 30 percent by weight of soil particles finer than the No. 200 sieve. Based on the boring results, the majority of the on-site material may not be usable as structural fill.

C. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups MH, CH, OL, OH and PT.

D. Backfill and Fill Materials: Satisfactory soil materials.

E. Subbase and Base Material: naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, ASTM D 2940. Graded aggregate for subbase courses shall meet the requirements for G A S/B as shown in Table 312300-1. Recycled concrete (RC-6) sub-base and fill material, acceptable except under building slab and pavement areas.

Table 312300-1

SIEVES		**MASS PERCENT PASSING**	
Mm	Standard	BRG S/B	G A S/B
100	4 in.		
90	3.5 in.		
63	2.5 in.	100	
50	2 in.		100, ± 3
37.5	1.5 in.		90 - 100, ± 5
25	1 in.	90 - 100	
19	¾ in.		
12.5	½ in.	60 - 100	
9.5	3/8 in.		
4.75	#4		30 - 60, ± 10
2.36	#8		
2.0	#10	35 - 90	
0.60	#30		
0.425	#40	20 - 55	
0.075	#200	5 - 25	0 - 12, ± 5

F. Engineered Fill: Subbase or base materials

G. Bank Run Gravel for subbases: Bank Run Gravel for subbase courses shall meet the requirements for BRG S/B as shown in Table 312300-1.

H. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, AASHTO M43, coarse aggregate grading size 57, with 100 percent passing a 1 inch sieve and not more than 5 percent passing a No. 8 sieve.

I. Filtering Material: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing a 1inch sieve and 0 to 5 percent passing a No. 50 sieve.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick minimum, 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.

1. Tape Colors: Provide tape colors to utilities as follows:
   a. Red: Electric
   b. Yellow: Gas, oil, steam, and dangerous materials
   c. Orange: Telephone and other communications
   d. Blue: Water Systems
   e. Green: Sewer Systems

B. Filter Fabric: Manufacturer's standard nonwoven previous geotextile fabric of polypropylene, nylon, or polyester fibers, or a combination.

1. Provide filter fabrics that meet or exceed the listed minimum physical properties determined according to ASTM D4759 and the referenced standard test method in parentheses:

   a. Grab Tensile Strength (ASTM D 4362): 100lb.
   b. Apparent Opening Size (ASTM D 4751): #100 U.S. Standard sieve.
   c. Permeability (ASTM 4491): 150 gallons per minute per sq. ft.

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 earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

D. Tree protection is specified in the Division 31 Section 311000- "Site Clearing".

3.2 DEWATERING

A. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area.

B. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

C. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, and sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

1. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water to be removed from excavation to collecting or runoff areas. Do not use excavations as temporary drainage ditches.

3.3 BACKFILLING BELOW-GRADE AREAS

A. Completely fill below-grade areas and void resulting from the demolition of the site improvements and pavements with compacted fill, as described below, to the grades as shown as existing grades on the drawings.

1. Use satisfactory soil materials, as defined by ASTM D 2487, consisting of soil classified as ML or more granular and should have a liquid limit less than 40 and a plasticity index less than 20; free of rock or gravel large than 4 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter. However, materials used as backfill behind below grade walls or retaining walls should have classifications of SM, or more granular, in accordance with ASTM D 2487, and should have no more than 30 percent by weight of soil particles finer than the No. 200 sieve.
2. Prior to placement of compacted structural fill, the fill subgrade should be stripped of organic layers and then proofrolled under the observation of the Owners Testing Agency. A minimum 20-ton dump truck should be used for proofrolling. Areas of subgrade that exhibit pumping or contain organic material should be removed down to firm, natural soils. Any additional loose or unsuitable soils found should be removed and replaced with compacted fill.
3. Place fill materials in horizontal layers not exceeding 8 inches in loose depth. Compact each layer to a density not less than 95% of the maximum dry density when tested in accordance with ASTM D-698, Standard Proctor. In building and pavement areas, the top 12 inches of fill should be compacted to 98% of the maximum density when tested in accordance with ASTM D-698, Standard Proctor. Fill materials should be placed at moisture contents within $\underline{+2}$ points of the optimum moisture content. No compacted fill shall be placed unless a soils technician is present to monitor fill compaction.

B. Testing Agency shall verify compliance of borrow material at both the in-situ location and after the material has been brought to the site.

3.4 EXCAVATION

A. Explosives: Do not use explosives.

B. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.

3.5 STABILITY OF EXCAVATIONS

A. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

B. Slope sides of excavation to comply with local codes, ordinances, and requirements of authorities having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

3.6 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within tolerance of plus or minus ½ inches. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspection.

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 Appurtenances: Excavate to elevations and dimensions indicated within a tolerance of plus or minus ½ inches. Do not disturb bottom of excavations intended for bearing surface.

3.7 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevation and grades.

3.8 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated slopes, lines, depths, and invert 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 a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe conduit, unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels, of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.

1. For pipes or conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed

subgrade.

2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bells of loads and ensure continuous bearing of pipe barrel on bearing surface.

3.9 UNAUTHORIZED EXCAVATION

A. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Architect.

B. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the Architect.

3.10 APPROVAL OF SUBGRADE

A. Notify Engineer when excavations have reached required subgrade.

B. When Engineer determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Engineer.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

A. Backfill excavations promptly, but not before completing the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Testing, inspecting, and approval of underground utilities.
4. Concrete formwork removal.
5. Removal of trash and debris from excavation.
6. Removal of temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.13 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on unyielding bearing surface and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches of footings. Place concrete to level of 4 inches above bottom of footings.

C. Provide 4 inch thick concrete base slab support for piping or conduit less than 30 inches below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum 4 inches of concrete before backfilling or placing roadway subbase.

D. Place and compact initial backfill of satisfactory soil material or subbase material, free of particles large than 1 inch, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact material under pipe haunches and bring backfill evenly up to both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

E. Coordinate backfilling with utilities testing.

F. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.

G. Place and compact final backfill of satisfactory soil material to final subgrade.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.14 BUILDING SLAB DRAINAGE COURSE

A. General: Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.

B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.

1. Provide minimum 4 inches of drainage fill below all slabs. Drainage fill shall be an evenly graded mixture of natural or crushed gravel or crushed stone and natural sand with 95-100 percent passing a 1 inch sieve and less than 12 percent passing a No. 200 sieve. Place in a single layer and compact to a minimum of 95 percent of the maximum dry density, as determined by the Modified Proctor compaction test method ASTM D 1557. Overlay fill with vapor barrier below all slabs.

3.15 SUBSURFACE DRAINAGE BACKFILL

A. Subsurface Drain: Place a layer of filter fabric around perimeter of drainage trench or at footing, as

indicated. Place a 6 inch compacted course of filtering material on filter fabric to support drainage pipe. After installing and testing, encase drainage pipe in a minimum of 6 inches of compacted filtering material and wrap in filter fabric, overlapping edges at least 6 inches.

B. Impervious Fill: Place and compact impervious fill material for top 12" to final subgrade.

3.16 FILL

A. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstruction, and deleterious materials from ground surface prior to placing fills.

1. Plow strip, or break up sloped surface steeper than 1 vertical 4 horizontal so fill material will bond with existing surface. Compact all surfaces with a minimum 10-ton smooth drum or sheepfoot roller.

B. When subgrade or existing ground surface to receive fill has density less than required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.

C. Place fill material in layers to required elevations for each location listed below.

1. Under grass, use satisfactory excavated or borrow soil material.
2. Under walks, pavements, and footings use subbase or base material, or satisfactory excavated or borrow soil material.
3. Under steps and ramps, use subbase material.
4. Under piping and conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.

3.17 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 3 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact to specified density.
    a. Stockpile or spread and dry removed wet satisfactory soil material.

3.18 COMPACTION

A. Place backfill and fill 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 materials evenly on all sides of structures to required elevations to prevent wedging action. Place backfill and fill uniformly along the full length of each structure.

C. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Architect if soil density tests indicate inadequate compaction.

D. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D-698 (Standard Proctor):

1. Under structures, building slabs, steps, compact the top 12 inches of fill materials below subgrade to 98 percent maximum density. Each layer of backfill or fill material below the top 12 inches should be compacted to 95 percent maximum dry density.
2. Under pavement, compact the top 12 inches of fill materials below subgrade to 98 percent maximum density. Each layer of backfill or fill material below the top 12 inches should be compacted to 95 percent maximum dry density.
3. Under walkways, compact the top 6 inches below subgrade and each layer of backfill or fill material at 95 percent maximum density.
4. Under lawn or unpaved areas, compact the top 6 inches below subgrade and each layer of backfill or fill material at 95 percent maximum density.

E. Proofroll all areas which are to receive pavements and slab-on-grade for the proposed school building with vehicle having a minimum axle load of 20 tons. Unsuitable materials shall be removed and replaced with new compacted fill.

F. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

3.19 GRADING

A. General: Uniformly grade areas to a smooth surface free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between existing adjacent grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1.	Lawn or Unpaved Areas:	Plus or minus 2 inches.
2.	Walks:	Plus or minus 2 inches.
3.	Pavements:	Plus or minus 2 inches

C. Grading Inside Building Lines: Finish subgrade to a tolerance of 2 inches when tested with a 10-foot straightedge.

3.20 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course material on prepared subgrades. Place base course material over subbases to pavements.

1. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of ASTM D 4254 relative density.
2. Shape subbase and base to required crown elevations and cross-slope grades.
3. When thickness of compacted subbase or base course is 6 inches or less, place materials in a single layer.
4. When thickness of compacted subbase or base course exceed 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

B. Pavement Shoulders: Place shoulder along edges of subbase and base course to prevent lateral movement. Construct shoulders at least 12 inches wide of acceptable soil materials and compact simultaneously with each subbase and base layer.

3.21 DRAINAGE FILL

A. Under slabs-on-grade, place drainage fill course on prepared subgrade.

1. Compact drainage fill to required cross sections and thickness,
2. When compacted thickness of drainage fill is 6 inches or less, place materials in a single layer.
3. When compacted thickness of drainage exceeds 6 inches thick place materials in equal layers, with no layer more than 6 inches thick nor less than 3 inches thick when compacted.

3.22 FIELD QUALITY CONTROL

A. Testing Agency Service: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.

1. Perform field-in-place density tests according to ASTM D 1556 (sand cone method).
   a. Field-in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.

   b. When field-in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each difference type of material encountered, and at intervals as directed by the Engineer.
2. Footing Subgrade: Inspect bearing state at each column footing and at twenty foot intervals in wall footings, at the footing subgrade, to verify required bearing capacity.
3. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2000 sq. ft. or less of paved areas or building slab, but in no case fewer than three tests.
4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 50 feet or less of wall length, but no fewer than two tests along a wall face.
5. Trench Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 50 feet or less of trench, but no fewer than two tests.

B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and

moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained. Retesting will be paid by the Contractor.

3.23 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace material to depth directed by the Architect; reshape and recompact at optimum moisture content to the required density.

C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.

2. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.24 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Contractor shall remove and dispose of offsite all excess topsoil and/or borrow remaining after final grading has been completed.

1. Remove waste material, including unsatisfactory soil trash, debris, and legally dispose of off the Owner's property.

END OF SECTION

SECTION 31 25 00 – SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

D. Sediment and Stormwater Administration Maryland Department of the Environment, 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control, dated December 2011, and addendum thereto.

1.2 SUMMARY

A. The extent of soil erosion and sediment control facilities is shown on the Erosion and Sediment Control Plans, approved by the Baltimore City Soil Conservation District.

1.3 QUALITY ASSURANCE

A. Comply with local codes where applicable and to the requirements of all permits.

B. Comply with the provisions outlined in Division 1.

1.4 LEED SUBMITTALS

A. SS prerequisite 1, Construction Activity Pollution Prevention: Provide six photos of sedimentation and erosion control measures in place on two separate occasions during construction. 12 photos total are required.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Material requirements are specified on the drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of the soil erosion and sediment control facilities shall be as shown and specified on the Sediment/Erosion Control Plans and Detail sheets as shown on the Contract Drawings.

3.2 TIMING

A. All perimeter control shall be installed and approved by the Sediment Control Inspector as specified in the "Sequence of Construction" on the Contract Drawings.

3.3 MAINTENANCE

A. All soil erosion and sediment control measures shall be maintained continuously during the construction period.

B. Soil erosion and sediment control measures shall be inspected daily, and any measure which has been disturbed or damaged shall be repaired and restored to operating condition in accordance with the approved plan before the end of each work day.

3.4 REMOVAL

A. Soil erosion and sediment control measures shall not be removed until the removal has been authorized by the Sediment Control Inspector.

END OF SECTION

SECTION 32 12 00 – FLEXIBLE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching
3. Hot-mix asphalt overlays.
4. Asphalt surface treatments:
    a. Fog seals
    b. Slurries
5. Multi-purpose court seal coating.
6. Pavement-marking paint.

B. Related Sections:

1. Section 312300: Excavating and Filling
2. Section 321300: Rigid Paving

1.3 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the Baltimore City Standards and the Standard Specifications for Construction and Materials of the Maryland Department of Transportation, State Highway Administration, latest edition, are hereby by reference made a part of these specifications where applicable.

B. Bituminous concrete pavement shall consist of aggregate asphalt mixed and constructed in accordance with these specifications and placed to the depth, grade, and cross section shown on the Construction Details.

1.4 SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.

B. LEED Submittals:

1. Product Data for Credit MR 4: For recycled content materials, documentation indicating percentages of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
2. Product Data for Credit MR 5: For regional materials, documentation indicating location of manufacture and location of extraction or recovery of primary raw materials. Include statement indicating cost of each product with regional material content.
3. SS credit 7.1, Heat Island Effect, Non Roof: Provide manufacturer's cut sheets for all impervious paving materials, highlighting the Solar Reflectance Index (SRI) of the material.

C. Job-Mix Designs: For each job mix proposed for the Work.

D. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate dedicated handicapped spaces with international graphics symbol.

E. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

G. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.5 QUALITY ASSURANCE

A. Installed Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Manufacture Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-services performance.

1. Firm shall be a registered and approved paving mix manufacturer with the Baltimore City Department of Public Works or with the Maryland State Highway Administration.

C. Testing Agency Qualifications: The Owner will engage a qualified independent testing agency has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

D. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.

E. Asphalt-Paving Publication: Comply with AI's "The Asphalt Handbook", except where more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: Minimum surface temperature of 40 deg F.
2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
3. Asphalt Base Course: Minimum surface temperature of 32 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 40 deg F at time of placement.

B. Pavement-marking Paint: Apply pavement marking on clean, dry surfaces as specified at the manufacturer's recommended ambient, surface and material temperatures.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use locally available, extracted within 500 mile radius of Project Site, materials and gradation that exhibit a satisfactory record of previous installations. Bituminous concrete shall meet the requirements of the S.H.A. Specifications, Section 904, as later specified herein or as indicated on the drawings.

B. Coarse Aggregate: Sound, angular crushed stone; crushed gravel; or properly cured, crushed blast-furnace slag, complying with ASTM D 692-88.

C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone; gravel, properly cured blast-furnace slag; or combination thereof, complying with ASTM D 1073.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: ASTM D 3381 for viscosity-graded material, ASTM D 946 for penetration-graded material.

B. Undersealing Asphalt: ASTM D 3141, pumping consistency.

C. Prime Coat: ASTM D 2027; medium-curing cutback asphalt; MC-30, MC-70, or MC-250.

D. Tack Coat: ASTM D 977, emulsified asphalt.

E. Water: Portable.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.

B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

C. Paving Geotextile: Nonwoven polypropylene, specifically designed for paving applications, resistant to chemical attack, rot, and mildew.

D. Pavement-Marking Paint: Latex, waterbased emulsion, ready mix complying with FS-TT-P-1952 F, Type 1.

1. Color: White.

2. Color: Yellow.

E. Glass Beads

F. Provide Crusher Run (CR-6) subbase and fill material.

2.4 MIXES

A. Hot-Mix Asphalt: Provide dense, hot-laid, hot- mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Base Course: Hot mix Asphalt Superpave 19.0 mm – PG 64-22 Level 2.
2. Surface Course: Hot mix Asphalt Superpave 9.5 mm – PG 64-22 Level 2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Architect in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.2 COLD MILLING

A. Clean existing paving surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement, including hot-mix asphalt and as necessary, unbound-aggregate base course, by cold milling to grades and cross sections indicated.

1. Repair or replace curbs, manholes, and other construction damaged during cold milling.

3.3 PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.
2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly broken pavement. Prepare and patch with hot-mix asphalt.

C. Leveling Course: Install and compact leveling course consisting of dense-graded, 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.

D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of ¼ inch. Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

E. Tack Coat: Apply uniformly to existing surface of previously constructed asphalt or Portland cement concrete paving to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.01 to 0.05 gal./sq. ft. of surface.

1. Allow tack coat to cure undisturbed before paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface or compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted-aggregate base at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 72 hours minimum.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use just 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.
3. Prime coat shall be applied at a temperature of 75° to 100°.

3.5 HOT-MIX ASPHALT PLACING

A. Bituminous concrete shall not be placed when the ambient air and surface temperature is below 40°F. When the surface temperature falls below these limits, material enroute may be placed at the risk of the Contractor.

B. Apply prime and tack coats when ambient temperature is above 40° F and when temperature has not been below 32° F for 12 hours immediately prior to applications. Do not apply when base is wet or contains an excess of moisture.

C. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted. Place each course to required grade, cross section, and thickness, when compacted.

1. Place hot-mix asphalt base course in number of lifts and thickness indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 225 degrees F.
4. Begin applying mix 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.

D. Place paving in consecutive strips no less than 10 feet wide, except where 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. Complete asphalt base course for a section before placing asphalt surface course.

E. Promptly correct surface irregularities in pacing course behind paver. Use suitable hand tools to remove excess material forming high spots. File depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure 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.
2. Offset longitudinal joints in successive course a minimum of 6 inches.
3. Offset transverse joints in successive course by the length of the paver.
4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AL's "The Asphalt Handbook".
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.

B. Longitudinal and transverse joints shall be made in a careful manner.

1. Well bonded and sealed joints are required. If necessary, in order to obtain this result, joints shall be painted with asphalt.
2. Both longitudinal and transverse joints in successive courses shall be staggered so as not to be one above the other.
3. Longitudinal joints shall be staggered a minimum of 6 inches and shall be arranged so that the longitudinal joint in the top course being constructed shall be at the location of the lane dividing the traffic lanes.

C. Joints between old and new pavements, or between successive days work, shall be carefully made in such a manner as to ensure a thorough and continuous bond between old and new surfaces.

1. In the case of surface courses, the edge of the old and new surface course shall be cut back for its full depth so as to expose a fresh surface.
2. To obtain a well bonded joint, the surface shall be painted with hot asphalt, after which the hot surface mixture shall be placed in contact with it and raked to a proper depth and grade.
3. Before placing the mixture against them, all contact surfaces, of curbs, gutters, headers, manholes, etc., shall be painted with a thin uniform coating of hot asphalt cement or asphalt cement dissolved in Naptha.

3.7 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 vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools below 185 deg F (85 deg C).

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joint and outside edge. Examine surface immediately after breakdown rolling for indicated grade, and smoothness, Repair surface by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.

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 an in-place density of 92.0 to 97.0 percent of the maximum density.

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 still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over are affected 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 to less than 140 ^{o} F or as directed by the Engineer.

3.8 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base 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.

3.9 SURFACE TREATMENTS

A. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry to smooth ridges and provide a uniform, smooth surface.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to cure per the pavement manufacturer’s recommendations before starting pavement marking.

D. Pavement surfaces shall be dried free of oil, dirt, grease, and other contaminants prior to application of pavement markings. Surfaces not in conformance shall be cleaned by the Contractor to a width of 4 to 6 inches wider than the markings to be applied.

E. Existing pavement markings that conflict with new or altered traffic pattern shall be completely removed by the Contractor. The method used by the Contractor for removal shall not damage the pavement surface and shall be approved by the Engineer. Any pavement damaged shall be repaired or replaced as determined by the Engineer at no additional cost to the Owner.

F. Apply paint with mechanical equipment to produce pavement marking of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.

1. Reference laboratory density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D1559, and compacted according to job-mix specifications.
    a. One core sample will be taken for every 100 sq. yd. or less of installed pavement, but in no case will fewer than 3 cores be taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

SECTION 32 13 00 – RIGID PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 SUMMARY

A. This Section includes exterior Portland cement concrete paving for the following:

1. Curbs and gutters.
2. Walkways.

B. Related Sections:

1. Section 312300: Excavating and Filling
2. Section 033300: Cast-in-Place Concrete

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specifications Sections.

B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.

C. LEED Submittals:

1. Product Data for Credit MR 4: For recycled content materials, documentation indicating percentages of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
2. Product Data for Credit MR 5: For regional materials, documentation indicating location of manufacture and location of extraction or recovery of primary raw materials. Include statement indicating cost of each product with regional material content.
3. SS credit 7.1, Heat Island Effect, Non Roof: Provide manufacturer's cut sheets for all impervious paving materials, highlighting the Solar Reflectance Index (SRI) of the material.

D. Design mixes for each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

E. Laboratory test reports for evaluation of concrete materials and mix design tests.

F. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificate shall be assigned by manufacturer and Contractor certifying that each material item complies with or exceed requirements. Provide certification from admixture manufacturers that chloride content complies with requirements.

1.4 QUALITY ASSURANCE

A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.
   1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings".
   2. ACI 318, "Building Code Requirements for Reinforced Concrete".
   3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".

B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Concrete Testing Service: The Owner will engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

1.5 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

B. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 fL volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars and Tie Bars: ASTM A 615, Grade 60, deformed.

   1. Provide steel with minimum 95 percent recycled content, 60 percent post-consumer.
   2. Provide steel manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

B. Welded Steel Wire Fabric: ASTM A 185.

1. Furnish in flat sheets, not rolls, unless otherwise acceptable to Architect.

C. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with end square and free of burrs.

D. Hook Bolts: ASTM A 307, Grade A bolts, internally and externally threaded. Design hook bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

E. Supports for Reinforcement: Chairs, spacers, dowel bar supports, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.

1. Use supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.

1. Use one brand of cement throughout project unless otherwise acceptable to Architect.
2. Mix shall be in accordance with the Portland Association publication #IS174.02T "Concrete for Small Jobs".
3. All concrete shall be 3000 psi, air-entrained (5% $\pm$ 1%) and the proportions by volume shall be in accordance with Table 321300-1,unless otherwise noted.
4. Contractor shall furnish to the Owner delivery tickets for the concrete at the time of delivery.

TABLE 321300-1
PROPORTIONS BY VOLUME

Maximum Size Coarse Aggregate	Cement	Sand	Aggregate	Water
3/8"	1	2-1/4	1-1/2	1/2
1/2"	1	2-1/4	2	1/2
3/4"	1	2-1/4	2-1/2	1/2
1"	1	2-1/4	2-3/4	1/2
1-1/2"	1	2-1/4	3	1/2

B. Normal-Weight Aggregates: ASTM C 33, Class 4, and as follows: Provide aggregates from a single source.

1. Maximum Aggregate Size: 1-1/2 inches
2. Do not use fine or coarse aggregates that contain substances that cause spalling.
3. Local aggregates not complying with ASTM C33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be

used when acceptable to Architect.

4. Provide aggregate extracted or recovered within 500 mile radius of Project Site.

C. Water: Potable.

2.4 ADMIXTURES

A. Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. Products: Subject to compliance with requirements, provide one of the following:

1. Air-Entraining Admixture:

a. Air-Tite or Amex 210; Cormix Construction Chemicals.
b. Air-Mix or Perma-Air; Euclid Chemical Co.
c. Darex AEA or Daravair; W.R. Grace & Co.
d. MB-VR or Micro-Air, Master Builders, Inc.
e. Sealtight AEA; W.R. Meadows, Inc.
f. Sika AER; Sika Corp.

2. Water-Reducing Admixture:
a. Chemtard; ChemMasters Corp.
b. Type A Services; Cormix Construction Chemicals
c Eucon WR-75; Euclid Chemical Co.
d. WRDA; W.R. Grace & Co.
e. Pozzolith Normal or Polyheed; Master Builders, Inc.
f. Metco W.R.; Metalcrete Industries
g. Plastocrete 161; Sika Corp.

2.5 CURING MATERIALS

A. Moisture-Retaining Cover: polyethylene sheet material shall have finished product weight of not less than 10 oz. per square yard.

B. Liquid Membrane-Forming Curing Compound: AASHTO M-148.

C. Products: Subject to compliance with requirements, provide one of the following:

1. Liquid Membrane-Forming Curing Compound:
a. Clear Cure; Anti-Hydro Co., Inc.
b. Spartan-Cote; The Burke Co.
c. All Resin; Conspec Marketing & Mfg. Co.
d. Sealco 309; Cormix Construction Chemicals
e. Day-Chem Cure and Seal; Dayton Superior Corp.
f. Diamond Clear; Euclid Chemical Corp.
g. #64 Resin Cure-Clear; Lambert Corp.

h. L&M Cure R; L&M Construction Chemicals
i. Masterkure; Master Builders, Inc.
j. 3100 Series; W.R. Meadows, Inc.
k. Seal N Kure; Metalcare Industries
l. Kure-N-Seal; Sonneborn-Chemrex
m. Horn Clear Seal; Tamms/A.C. Horn

2.6 RELATED MATERIALS

A. Boiled Linseed Oil Mixture: Combination of boiled linseed oil and mineral spirits, complying with AASHTO.

B. Bonding Agent: Acrylic or styrene butadiene.

C. Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.

D. Products: Subject to compliance with requirements, provide one of the following:

1. Dry-Shake Color Hardener
2. Bonding Agent
   a. Acrylic Bondcrete; the Burke Co.
   b. Stringbond; Conspec Marketing and Mfg. Co.
   c. Day-Chem Ad Bond (J-40); Dayton Superior Corp.
   d. SBR Latex; Euclid Chemical Co.
   e. Daraweld C; W.R. Grace & Co.
   f. Everbond; L&M Construction Chemicals, Inc.
   g. Acryl-Set; Master Builders, Inc.
   h. Intralok; W.R Meadows, Inc.
   i. Acrylpave; Metalcare Industries
   j. Sonocrete, Sonneborn-Chemrex
   k. Stonlok LB2; Stonhard, Inc.
   l. Strong Bond; Symons Corp.
3. Epoxy Adhesive:
   a. Burke Epoxy M.V.; the Burke Co.
   b. Spec-Bond 100; Conspec Marketing and Mfg. Co.
   c. Resi-Bond (J-58); Dayton Superior
   d. Euco-Epoxy System #452 or #620; Euclid Chemical Co.
   e. Concresive Standard Liquid; Master Builders, Inc.
   f. Rezi-Weld 1000; W.R. Meadows, Inc.
   g. Metco Hi-Mod Epoxy; Metalcrete Industries
   h. Sikadur 32 Hi-Mod; Sika Corp.
   i. R-6000 Series; Symons Corp.
   j. Epoxtite Binder 2390; Tamms/A.C. Horn, Inc.

2.7 CONCRETE MIX

A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified

independent testing agency for preparing and reporting proposed mix designs.

1. Do not use the Owner's field quality-control testing agency as the independent testing agency.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:

1. Compressive Strength (28-Day): 3000 psi
2. Maximum Water-Cement Ratio at Point of Placement: 0.45
3. Slump Limit at Point of Placement: 3 inches.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows with a tolerance of plus or minus 1-1/2 percent.

1. Air Content: 5.5 percent for 1-1/2-inch maximum aggregate.

D. Fiber Reinforcement: Add to mix at a rate of 1/5 lb per cu. yd., unless manufacturer recommends otherwise.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, project condition, weather, test results, or other circumstances warrant.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

1. When air temperature is between 85 deg F 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.

2.9 JOINT MATERIALS

A. Zip strip control joint manufactured by Superior Featherweight Tools, Inc. or approved equal.

B. Performed Joint Fillers

1. The cork type shall be in accordance with AASHTO M153.
2. The bituminous fiber type shall be in accordance with AASHTO M213 with the bituminous content determined by AASHTO T164.
3. The weathering test shall be deleted for either type of material.

C. Roofing paper to be used in construction joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weight less than 39.8 lbs/square foot and shall not crack when bent over 1/2 inch radius at room temperature.

2.10 JOINT SEALANTS

A. Compatibility: Sealant fillers and all adjacent materials shall be compatible as demonstrated by sealant manufacturer testing.

B. Colors - Provide color of exposed joint sealants to comply with the following:

1. Match colors of concrete.

C. Cold Applied Joint Sealants shall be one part, polyurethane-base sealant for concrete pourable, chemically curing elastomeric formulation complying with the following requirements relative to formulation with ASTM C 920 for Type s, Grade NS, Class 25, and Uses indicated.

2.11 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates; sealants, primers, and other joint fillers, and are approved for applications indicated by sealants manufacturer based on field experience and laboratory testing.

B. Backer Rods for Cold Applied Sealants: Performed, compressible, resilient, nonwaxing, nonextruding strips of flexible, plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

1. Closed cell polyethylene foam, nonabsorbent to liquid water and gas, and nonoutgassing in unruptured state.
2. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 2.5 pcf and tensile strength of 35 psi per ASTM D 1623, and with water absorption less than 0.02 gram/cubic centimeter per ASTM C 1083.
3. Either material indicated above.

C. Bond Breaker Type: Polyethylene tape of other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesions would result in sealant failure. Provide self-adhesive tape where applicable.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

B. Remove loose material from compacted subbase immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in pace at least 24 hours after concrete placement

B. Check completed formwork and screeds for grade and alignment to following tolerances:

1. Top of Forms: Not more than 1/2 inch in 10 feet.
2. Vertical Face on Longitudinal Axis: Not more than 1/2 inch in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for 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 maximum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and laces splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 JOINTS

A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.

B. Contraction joints: Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings. Construct contraction joints for a depth equal to at least 1/4 of the concrete thickness, as follows:

1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8 inch wide joints into hardened concrete when cutting action will not tear, abrade, or otherwise damage surface and before development of random contraction cracks.
3. Inserts: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.

C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than 1/2 hour, unless paving terminates at isolation joints.

1. Provide performed galvanized steel or plastic keyway-section forms or bulkhead forms with key, unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete.
2. Continue reinforcement across construction joints unless indicated otherwise. Do not continue

reinforcement through sides of strip paving unless indicated.
3. Provide tie bars at sides of paving strips where indicated.
4. Use bonding agent one existing concrete surfaces that will be joined with fresh concrete.

D. Isolation Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 40 feet, unless indicated otherwise.
2. Extend joint filler full width and depth of joint, not less than ½ inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
3. Furnish joint filler in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protection cap after concrete has been placed on both sides of joint.

E. Walks shall be constructed to match existing concrete at existing road tie-ins.

1. Expansion joints between building and pavement shall be cork.
2. Pavements shall be separated from curbs by a construction joint using felt roofing paper material.
3. "Zip Strip" control joint to be installed at a maximum of 24' and between existing walks and new concrete.
4. Saw cut control joints are not permitted.
5. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one half of dowel length to prevent concrete bonding to one side of joint.

3.5 JOINT SEALANT INSTALLATION

A. Clean out joints before installing joint sealants to comply with recommendations of manufacturer.

B. Comply with Joint Manufacturer printing installation instructions and recommendations of ASTM C 962 for use of joint sealants.

C. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to a smooth, uniform bead to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint.

1. Do not use tooling agent that discolor sealants or adjacent surface or are not approved by the sealant manufacturer.
2. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so they are without deterioration at final acceptance.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete framework installation, reinforcing steel, and item to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove ice, snow, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements with ACI 304R 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.

1. When concrete placing is interrupted for more than 1/2 hour, place a construction joint.

F. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidation concrete complying with ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.

H. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agency if acceptable to Architect.

J. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutter to required cross section, lines, grade, finish and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.

K. Slip Form Pavers: When automatic machine placement is used for paving, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish, and jointing as required for formed paving.

1. Compact subbase and prepared subgrade of sufficient width to prevent displacement of pave machine during operation.

L. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

M. Cold Weather Placement: Comply with provision of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. Concrete placement shall begin only when the ambient air and surface temperature is at least 40□F and rising and discontinued anytime the temperature falls below 40□ F. Placing concrete on a frozen base is prohibited.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agent or chemical accelerators unless otherwise accepted in mix designs.

N. Hot Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 70□ F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperation immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft sport, or dry areas.

3.7 CONCRETE FINISHING

A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across concrete, perpendicular to line of traffic, to provide a uniform gritty texture finish.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across concrete surface perpendicular to line of traffic to provide a uniform fine line texture finish.

B. Final Tooling: Tool edges of paving, gutter, curbs, and joints formed in fresh concrete with a jointing tool to the following radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

1. Radius: 3/8 inch

3.8 CONCRETE PROTECTION AND CURING

A. General: Following texturing and edging, the concrete shall be cured for a minimum of 72 hours. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot

weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instruction after screeding and bull floating, but before floating.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture-Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and keep continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL TESTING

A. The Owner will employ a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
   a. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
   b. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test but no less than one test for each day's pour of each type of air-entrained concrete.
   c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40□ F and below and when 80□ F and above, and one test for each set of compressive-strength specimens.
   d. Compression Test Specimens: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
   e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. But less than 25 cu. yd., plus one set for each additional 50 cu. yd. Test one specimen at 7 days, test two specimens at 28 days, and

retain one specimen in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
3. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operation and provide corrective procedures for protecting and curing the in-place concrete.
5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test results falls below specified compressive strength by more than 500 psi.

B. Test results will be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.

C. Nondestructive Testing: Impact hammer sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

D. Additional Tests: The testing agency will make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.

B. Drill test cores where directed by Architect when necessary, to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete 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 concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 323113

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Privacy slats.

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: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.

D. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Sample warranty.

1.5 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7:

1. Design Wind Load: 110 MPH

a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F 1043, Schedule 40 steel pipe
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter of 0.192 inch.

a. Mesh Size 1inch
b. Polymer-Coated Fabric: ASTM F 668, Class 1 over zinc-coated steel wire.

1) Color: As selected by Architect from manufacturer's full range, according to ASTM F 934.

c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled at both selvages.

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: As indicated on Drawings

2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40

    a. Line Post: 2.875 inches (73 mm) in diameter
    b. End, Corner, and Pull Posts: 2.875 inches (73 mm) in diameter

3. Horizontal Framework Members: Intermediate top and bottom rails according to ASTM F 1043.
4. Brace Rails: ASTM F 1043.
5. Metallic Coating for Steel Framework:

    a. Type A zinc coating.
    b. Type B zinc with organic overcoat.
    c. External, Type B zinc with organic overcoat and internal, Type D zinc-pigmented coating.
    d. Type C, Zn-5-Al-MM alloy coating.
    e. Coatings: Any coating above.

6. Polymer coating over metallic coating.

    a. Color As selected by Architect from manufacturer's full range, according to ASTM F 934.

2.4 TENSION WIRE

A. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, tension wire according to ASTM F 1664, Class 1-coated steel wire.

1. Color: As selected by Architect from manufacturer's full range, according to ASTM F 934.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and double swing gate types.

1. Gate Leaf Width: as indicated
2. Framework Member Sizes and Strength: Based on gate fabric height as indicated.

B. Pipe and Tubing:
1. Gate Posts: Round tubular steel.
2. Gate Frames and Bracing: Round tubular steel

C. Frame Corner Construction: Assembled with corner fittings.

D. Hardware:

1. Hinges: 180-degree inward and outward swing.
    a. Provide self-closing spring hinges on gates indicated.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

3. Lock: provide master-keyed, high security, weather resistant padlock with
   a. Shackle: Boron hardened steel, 7/16" diameter, shrouded
4. Swing gate wheels for gate panels exceeding 6' – 0" width: Tack weld fitting to gate frame on the latch side of the gate
   a. Wheel Hub: 3-7/8"
   b. Wheel diameter: 5-7/8"
   c. Wheel width: 1-1/2"

2.6 FITTINGS

A. Provide fittings according to ASTM F 626.

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of zinc.

   a. Polymer coating over metallic coating.

2.7 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

B. Post Setting: Set posts in concrete curb at indicated spacing into firm, undisturbed or compacted soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp adjacent soils for consolidation. Protect aboveground portion of posts from concrete splatter.
   a. Concealed Concrete: Place top of concrete 2 inches (50 mm) below grade to allow covering with surface material.
   b. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
   c. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

C. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.

D. Line Posts: Space line posts uniformly at 120-inches o.c.

E. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric.

3.4 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 323113

SECTION 329113

SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:

1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
2. Section 329700 "Vegetated Roof Assemblies" for growing media (soil).

1.2 DEFINITIONS

A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

B. Imported Soil: Soil that is transported to Project site for use.

C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

D. 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.

E. 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.

F. 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.

G. 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.

H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 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.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of [sandy loam] [loam] [silt loam] [loamy sand] [or] [sand] soil <Insert soil texture> 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 (100 mm) deep, not from [agricultural land,]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 to 7 and minimum of 6 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] <Insert number> percent by dry weight of the imported soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding [2 inches (50 mm)] [3 inches (75 mm)] <Insert dimension> 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:

    a. Ratio of Loose Compost to Soil: 1:3 by volume.
    b. Ratio of Loose Sphagnum or Muck Peat to Soil: <Insert ratio> by volume.
    c. Weight of Lime: 50 pounds per 1000 sq. ft. (100 sq. m) per 6 inches (150 mm) of soil depth.
    d. Weight of Commercial Fertilizer: per manufacturer's recommendations per 6 inches (150 mm) of soil depth.
    e. Weight of Slow-Release Fertilizer: per manufacturer's recommendations per 6 inches (150 mm) of soil depth

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, 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 (2.36-mm) sieve and a minimum of 75 percent passing through a No. 60 (0.25-mm) sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through a No. 60 (0.25-mm) sieve.
3. Form: Provide lime in form of ground dolomitic limestone, calcitic limestone or mollusk shells.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.

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 (0.30-mm) sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 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: Limited to leaves.
2. Reaction: pH of 5.5 to 8
3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content:50 to 60 percent of dry weight.

6. Particle Size: Minimum of 98 percent passing through a 1-inch (25-mm) sieve.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) 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 (13-mm) 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. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

E. 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.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. 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. (0.5 kg/100 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

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.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) 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 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 3-inch (75-mm) 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 8 inches (200 mm. Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Spread unamended soil to total depth of 4 inches (100 mm), 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 and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

    a. Mix lime 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 (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) 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 D 698 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 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches (100 mm) 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.

3.5 PROTECTION AND CLEANING

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."

B. 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.

C. 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 329113

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SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary and permanent Seeding.
2. Turfgrass Sodding.
3. Temporary Mulching
4. Turf Establishment
5. Mulching
6. Fertilizing
7. Pesticide and Herbicide

1.2 DESCRIPTION

A. Work consists of furnishing and placing fertilizer, temporary and permanent turf seed, mulch, wood cellulose fiber and temporary straw mulch on cuts, fills and other soil areas, which cannot be shaped and permanently vegetated for an extended period of time as specified in the Contract Documents or as directed by the Architect.

1.3 DEFINITIONS

A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides,

rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and fertilizers to produce a soil mixture best for plant growth. See Section 32 91 15 "Soil Preparation (Performance Specification)" and drawing designations for planting soils.

1.4 SUBMITTALS

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

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass and sod identifying source, including name and telephone number of supplier.

C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

D. Qualification Data: For landscape Installer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

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1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Landscape Industry Certified Technician - Exterior.

b. Landscape Industry Certified Lawncare Manager.

c. Landscape Industry Certified Lawncare Technician.

3. Pesticide Applicator: State licensed, commercial.

1.7 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.

1.8 MEADOW MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 40 days from date of Substantial Completion.

B. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep meadow uniformly moist.

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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 meadow at a minimum rate of 1/2 inch (13 mm) per week until planting is established.

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. General. All seed, seed mixes and sod shall be free from Maryland prohibited noxious weed seeds and the following:

1. Annual Bluegrass, Giant Foxtail, Bermuda grass, Horse Nettle, Bindweed, Spurred Anoda, Cocklebur, Wild Garlic, Corn Cockle, Wild Onion and Dodder.

C. Seed will be sampled and tested by an inspector from the Turf and Seed Section, Maryland Department of Agriculture (MDA), Annapolis, Maryland. All seed containers shall be tagged with a MDA supervised mix program seed tag. Seed shall comply with the Maryland Seed Law, Agricultural Article of the Annotated Code of Maryland. The authority for seed names shall be the current printing of USDA, Agriculture Handbook.

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D. Grass and legume seeds shall conform to the latest Construction directives regarding cultivars and varieties and the following:

SEED	PURITY NOT LESS THAN %	WEED SEED NOT MORE THAN %	MINIMUM GERMINATION (including hard seed) %	HARD SEED NOT TO EXCEED %
Kentucky Bluegrass: (Poa pratensis)	90	0.4	80	—
Canada Bluegrass: (Poa compressa)	90	0.5	80	—
Redtop: (Agrostis gigantea)	92	0.7	80	—
Lehmann's Lovegrass: (Eragrostis lehmanniana)	98	0.5	80	—
Foxtail Millet: (Setaria italica)	99	0.1	80	—
Hard and Fine Fescue: (Festuca longifolia)	98	0.5	85	—
Sheep Fescue: (Festuca ovina)	98	0.5	85	—
Tall Fescue: (Festuca arundinacea)	98	0.5	90	—
Chewings Fescue: (Festuca rubra commutata)	98	0.5	85	—
Oats: (Avena sativa)	99	0.5	90	—
Crownvetch: (Coronilla varia)	98	0.5	80	30
Serecia Lespedeza: (Lespedeza cuneata)	98	0.5	85	20
Birdsfoot Trefoil: (Lotus corniculatus)	97	0.7	85	20
Weeping Lovegrass: (Eragrostis curvula)	98	0.5	80	—
Barley: (Hordeum vulgare)	98	0.3	90	—
Rye Grain: (Secale cereale)	98	0.1	85	—
Perennial Ryegrass: (Lolium perennial)	98	0.5	85	—

E. Seed Species:

1. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

F. Seed Mixes.

1. The Contractor or seed supplier shall notify the Turf and Seed Section, Maryland Department of Agriculture, Annapolis, Maryland, at least ten (10) days prior to the mixing date as to the hour, date and location of the mixing operation. The Contractor or seed supplier shall assume charges for seed inspections and seed testing service. Seed mixes shall conform to the following:

   a. Seed Mix No. 1:

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1) 85% Tall Fescue (Certified Seed Only)

2) 1 0% Kentucky Bluegrass (Certified Seed Only)

3) 5% Perennial Rye grass (Certified Seed Only)

b. Seed Mix No. 2:

1) 60% Kentucky Bluegrass (Certified Seed Only)

2) 40% Fine (Chewings, Creeping Red, Hard, Sheep) Fescue (Certified Seed Only)

c. Temporary Seed Mix

1) 95% Barley or Rye

2) 5% Foxtail Millet

G. Grass-Seed Mix and Seasons

SEEDING SEASONS AND SEED MIXES		
SPRING AND FALL MONTH/DAY	SUMMER MONTH/DAY	LATE FALL MONTH/DAY
Permanent Seed Mix		
3/1 to 5/15 and 8/1 to 10/20	5/16 to 7/31	10/21 to 11/20
No Additives	Plus Additive A	Plus Additive B
Plus Additive C for seeding: a. On rippable rock. b. Areas 30 ft or greater from the edge of the payment. c. Slopes 3:1 and steeper.		
Refer to 2.1.D for seed mix contents: A = Lovegrass or Foxtail Millet B = Temporary Seed Mix C = Serecia Lespedeza		

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

2.2 TURFGRASS SOD (ADD ALTERNATE)

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass

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Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
2. Sun and Partial Shade: Proportioned by weight as follows:

   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewings red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).

3. Shade: Proportioned by weight as follows:

   a. 50 percent chewings red fescue (Festuca rubra variety).
   b. 35 percent rough bluegrass (Poa trivialis).
   c. 15 percent redtop (Agrostis alba).

2.3 MULCH (STRAW): Refer to Section 32 “Erosion and Sediment Control”.

2.4 WOOD CELLULOSE FIBER

A. Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics which will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form homogeneous slurry. The fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system. The slurry shall contain a green dye that provides easy visual inspection for uniformity of application. The manufacturer shall furnish certification (A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer) showing conformance to the following:

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WOOD CELLULOSE FIBER REQUIREMENTS	
Particle Length, inch	Approximately 1/2
Particle Thickness, inch	Approximately 1/16
Net Dry Weight Content	Minimum as stated on bag
TAPPI* T 509, pH	4.0–8.5
Ash Content, TAPPI* Standard T 413, % max	7.0
Water Holding Capacity, % min	90

* Technical Association of Pulp and Paper Industry

B. The material shall be delivered in packages of uniform weight which shall not exceed seventy-five (75) lb net weight and shall bear the name of the manufacturer, the net weight and a supplemental statement of the net weight content.

2.5 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade conforming to all State and Federal regulations and the Standards of the Association of Official Analytical Chemists. 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. Standard analyses shall be one of the following:

   a. 0-20-20,

   b. 5-20-20,

   c. 10-10-10,

   d. 10-20-10,

   e. 10-22-22

2. Each shall contain (fifty percent (50%) nitrogen from 38-0-0 urea form), 20-20-20 and 38-0-0 (urea form). All analyses are subject to approval by the Architect prior to application.

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B. Fertilizer Packets: Fertilizer shall be contained in a slow release polyethylene perforated bag with micropore holes for controlled feeding. The bag shall contain four (4) oz. of water-soluble fertilizer, analysis 16-8-16 to be effective for approximately eight (8) years.

1. Minimum guaranteed analysis of the packets shall be as follows:

MINIMUM ANALYSIS	
Total Nitrogen (N) 16%	9% Ammoniacal Nitrogen (NH_3N) 7% Nitrate Nitrogen (NO_3N)
Available Phosphoric Acid (P_2O_5)	8% from Ammonium Phosphate (NH_4PO_4)
Soluble Potash (K_2O)	16% from Potassium Chloride (KCl)
Potential Acidity equivalent to 850 lb Calcium Carbonate ($CaCO_3$) per ton.	

C. Fertilizer Tablets: Fertilizer tablets shall consist of a minimum twenty-one (21) gram tablet containing a slow release (two (2) year) fertilizer, analysis 20-1 0-5.

1. Minimum guaranteed analysis of the tablets shall be as follows:

MINIMUM TABLET ANALYSIS	
Total Nitrogen (N) 20%	7% Water Soluble Organic Nitrogen 13% Water Insoluble Organic Nitrogen
Available Phosphoric Acid (P_2O_5)	10%
Soluble Potash (K_2O)	5%

D. Iron Sulfate: Iron sulfate shall be an approved horticultural product produced as a fertilizer for supplying iron and as a soil acidifier.

2.6 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

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C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of [2 to 5] <Insert range or value> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

2.7 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.

PART 3 - EXECUTION

3.1 PESTICIDE APPLICATION

A. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. All pesticide applications shall be performed under the supervision of a certified applicator of pesticides (Category Ill A or VI).

B. Herbicide. All vegetation in the seeding area shall be eradicated prior to seeding by use of herbicide. The herbicide shall be glyphosate with a wetting agent mixed with water and a water soluble marking dye, applied at the following rates:

1. Herbicide: Five (5) lb per acre of active ingredient
2. Marking Dye: Six to fifteen (6 to 15) oz per acre
3. Water: Forty to fifty (40 to 50) gal per acre

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C. Reports. The Contractor shall submit daily herbicide application reports to the Architect using City forms.

3.2 MOWING

A. A minimum of two (2) weeks after herbicide treatment, the area to be seeded shall be mowed to a maximum height of one inch (1"). Clippings shall be removed prior to seeding.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil.

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 TEMPORARY SEEDING

A. Temporary seeding shall consist of preparing soil, seeding, fertilizing, mulching and applying wood cellulose fiber binder. Temporary seeding shall be done to areas that will remain undisturbed for one (1) month or more.

1. Soil Preparation. Soil shall be loosened from the grading operation. Compacted soil surfaces shall be loosened as approved by the Architect before seed is applied.

2. Seeding, Fertilizing and Mulching. Seeding, fertilizing and mulching shall conform to 32 92 23.01, Part 3, (Turf Establishment).Application Rates.

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TEMPORARY SEEDING		
MATERIAL	**LB PER 1000 FT^2**	**LB PER ACRE**
Temporary Seed Mix	2.9	125
Fertilizer (15-30-15)	10.3	450
Mulch (Straw or Hay)	91.8	4000
Wood Cellulose Fiber	17.2	750

3.5 TEMPORARY WOOD CELLULOSE MULCHING

A. Temporary wood cellulose mulching shall consist of applying wood cellulose fiber to those areas that will be disturbed in less than one (1) month.

1. Soil Preparation. Soil shall be left in the condition from the grading operation.

2. Mulching. Wood cellulose fiber shall be mixed with water in a hydroseeder and applied uniformly. Temporary wood cellulose mulching shall consist of wood cellulose fiber applied at the rate of thirty-four and four-tenths to forty-five and eight-tenths (34.4 to 45.8) lb per one thousand (1 000) ft2 or fifteen hundred to two thousand (1500 to 2000) lb per acre.

3.6 TEMPORARY STRAW MULCHING

A. Temporary straw mulching shall consist of applying temporary straw mulch by hand to small areas as determined by the Architect that will be disturbed in less than one (1) month.

1. Soil Preparation. Soil shall be left in the condition from the grading operation.

2. Mulching. Straw mulch applied by hand shall provide a loose depth of not less than one and one-half inches (1-112") nor more than three inches (3"). Ninety-five percent (95%) of the straw mulch will be six inches (6") or more in length. Temporary straw mulching shall be applied at the rate of ninety-one and eight tenths (91.8) lb per one thousand (1000) *W* or four thousand (4000) lb per acre and secured by a method approved by the Architect.

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3.7 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. 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.

3.8 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. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

END OF SECTION

SECTION 32 93 00

PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Tree-watering devices.
3. Landscape edgings.

1.2 DESCRIPTION

A. Work consists of the furnishing and planting of trees, shrubs, vines and seedling stock and plant establishment operations to complete the Work ass Specified in the Contract Documents or as directed by the Architect. Work shall be performed to meet the requirements of current Landscape Contractor Association (LCB) Specifications and Guidelines.

1.3 SEASONAL PLANT SCHEDULE

A. Planting shall be performed in accordance with the following annual schedule:

DECIDUOUS MATERIAL			EVERGREEN MATERIAL	
SEASON	CONTAINER GROWN	BALLED AND BURLAPPED	BALLED AND BURLAPPED	CONTAINER GROWN
Spring	3/1–6/15	3/1–4/30	3/15–4/30	3/15–6/15
Fall	8/15–12/15	10/15–12/15	9/1–11/15	8/15–11/15

1. Bare root plants shall not be planted while in leaf or during periods of freezing weather.
2. Container-grown materials shall not be planted if it has not been acclimated to weather conditions at the site and in the season of planting.
3. Planting shall not occur out of the seasons described herein without explicit written authorization of the Architect.

1.4 Pesticide Application

A. All Pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations.

1. All pesticide application shall be performed under direct supervision of of a certified applicator of pesticides (Category III A or IV).

    a. Daily pesticide Application reports shall be maintained by the Contractor.

    b. A completed copy for each day of application shall be provided to the Architect.

B. The Contractor shall replace in-kind, any plant material killed and prune any material damaged through any act of negligence by the Contractor in applying and handling pesticides on the project.

1.5 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

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. Some sources classify herbicides separately from pesticides.

C. 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 329115 "Soil Preparation (Performance Specification)" for drawing designations for planting soils.

D. 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.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples of each type of mulch.

1.8 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Sample warranty.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.10 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.11 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. 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.

C. Handle planting stock by root ball.

D. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

E. 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.

1.12 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.

2. Warranty Periods: From date of planting completion.

    a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
    b. Ground Covers, Biennials, Perennials, and Other Plants: 12months.
    c. Annuals: Three months.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, 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.

B. All plant grades shall be those established in the current edition of American Standards for Nursery Stock manual. Only one size per grade will be listed rather than a size range. The one size shall mean the minimum size for that grade and shall include plants from that size up to but not including the next larger grade size.

C. All plants, unless otherwise specifically permitted, shall be nursery grown and shall have been grown within plant hardiness zones 5, 6, 7 or the Virginia portion of zone 8A as recorded in the current edition of "Plant Hardiness Zone Map," prepared by the U.S. National Arboretum, Agricultural Research Service, U.S. Department of Agriculture.

D. All plant materials shall have normal, well-developed branches and a vigorous root system. They shall be healthy plants free from physical defects, plant diseases and insect pests. Plant materials grown in fields or blocks which show evidence of containing any parts of Johnson grass or ·Canada Thistle will be rejected.

E. Shade and flowering trees shall be symmetrically balanced. Major branches shall not have V shaped crotches capable of causing structural weakness. Trunks shall be free of unhealed branch removal wounds greater than a one inch (1") diameter.

F. Shade trees shall have a single main trunk. Trunks shall be free of branches below the following heights prior to installation:

REFORESTATION AND LANDSCAPE		STREET TREES	
CALIPER inch	HEIGHT ft	CALIPER inch	HEIGHT ft
1-1/2 to 2-1/2	5	2 to 2-1/2	6
3	6	3	7

2.2 Plant Names. The authority for all plant names shall be the current printing of "Hortus Third", except for llex opaca (American Holly), which shall be the current edition of the International Checklist of Cultivated llex. Representative samples of every shipment of plant materials shall be labeled as to genus, species and specified size.

ILEX OPACA	
Female	Male
Miss Helen Patterson	
Wyetta	Jersey Knight
Jersey Princess	David
Satyr Hill	Leather Leaf
Old Heavy Berry	
Dan Fenton	

A. Approved Varieties of llex opaca. When approved varieties of llex opaca are specified, the Contractor shall select from the following list of cultivated varieties.
   1. The Contractor shall supply ninety percent (90%) female varieties and ten percent (10%) male varieties unless otherwise specified by the Architect.

B. Plant Inspection. The initial inspection for conformance with these Specifications will be made at the nursery, holding area or job site. The condition of all plant material will be subject to reinspection for the life of the Contract. Inspection and tagging of plant material with a City seal prior to digging will be at the option of the Architect. Material arriving with broken seals (if tagging is required), broken or loose root balls, mechanical damage, insufficient protection and shriveled or undeveloped roots will be rejected. All container grown plants shall be well rooted, vigorous and established in the

size pot specified, shall have well balanced tops for their pot size, and shall not be root bound. All plant materials shall be declared and certified free from disease and insects of any kind as required by law for the necessary interstate or interdistrict transportation.

C. Plant Digging and Handling. All plants shall be dug in conformance with the digging Specifications in the current edition of "American Standard for Nursery Stock," unless otherwise specified.

D. Substitute Plants. No substitutions shall be made without the permission of the Architect and Tree Protection Expert. In cases where plant materials are not available at the time of planting, the Contractor shall submit, in writing, evidence that the plants are unavailable. The Architect and Tree Protection Expert will determine a suitable substitution. Street trees shall be approved by the City Arborist.

E. Maryland Plant Dealer's License. All Contractors performing planting Work and suppliers of trees, shrubs, vines, seedling stock, perennials and bulbs shall possess a Maryland Plant Dealer's License as required by the Maryland Plant Disease Control Law of the Annotated Code of Maryland.
   1. Out-of-state Contractors may substitute a dealer's license from their home state in lieu of the Maryland license. Contractors not possessing a similar plant dealer's license from their home state shall obtain a license from the Maryland Department of Agriculture.

2.3 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: 5-gram tablets.
   2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.4 MULCHES

A. Organic Mulch: Shredded hardwood bark.

2.5 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) 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.

2.6 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.

2.7 LANDSCAPE EDGINGS

2.8 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329115 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Layout: The Contractor shall perform all layout, bed preparation and soil amending as follows:

1. Layout: The Contractor shall provide the stakes and stake out the locations of all plants and the outlines of all seedling areas and plant beds as specified in the Contract Documents. No Work shall be started until the locations and outlines are approved by the Architect and Tree Protection Expert. Outline stakes for reforestation areas shall be spaced thirty feet (30') apart or as directed by the Architect. They shall be driven approximately one foot (1 ') into the ground and remain as a permanent means of outline identification through the life of the Contract.

E. Plant Bed Preparation: Existing weed growth in planting beds shall be sprayed with glyphosate with wetting agent conforming to the Maryland Pesticide Applicator's Law and to the manufacturer's recommendations. After a minimum of seven (7) days following herbicide application and prior to secondary weed growth, all planting beds shall be mowed to a height of one inch (1"). After mowing, woody material and debris shall be removed. On flat areas and slopes less than four to one (4:1), one inch (1") of

compost, peat moss or other approved organic soil amendments shall be spread over the entire surface of the planting bed and rototilled to provide a depth of six inches (6") of loose soil. After rototilling, plant beds shall be raked to provide an even planting surface, removing stones greater than three inches (3") and other foreign material. Plant beds on slopes four to one (4: 1) and steeper do not require surface application of sludge or rototilling

3.2 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.
3. Excavate at least 12 inches (300 mm) 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.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Plant Pit Soil Amendments: All plants shall be planted in planting pits. Soil amending shall be confined to the plant pit and the immediate surrounding area. Soil shall not be mixed while in a muddy or frozen condition. Soil clods two inches (2") or greater shall be pulverized before mixing.
    a. Soil for plants in the Heath Family (Ericaceous plants, i.e., Azaleas, Mountain Laurel, Sourwood, etc.) shall consist of existing soil into which the Contractor shall thoroughly incorporate twenty percent (20%) peat moss by volume. Based on administration soil test reports, the pH of soil shall be corrected by mixing iron sulfate or other soil pH modifiers approved by the Architect to provide a pH range from four to five (4.0 to 5.0).
    b. Soil for other plants except members of the Heath Family shall consist of existing soil at each planting pit location into which the Contractor shall thoroughly incorporate twenty percent (20%) by volume of compost or other approved organic soil amendments.
    2. Plant Pit Dimensions: Plant pit dimensions are based on standard ball and container sizes established by the administration. All plant pit dimensions shall be as specified in the Contract Documents and as follows: Refer to the following chart:

STOCK	HEIGHT	SPREAD	PIT DIMENSIONS	
			DIAMETER (inch)	DEPTH (inch)
Deciduous & Evergreen Shrubs & Trees B & B	—	—	2 times the ball diameter	Equal to ball depth
Deciduous & Evergreen Shrubs & Trees Container Grown	—	—	3 times the container diameter	Equal to container depth
Deciduous Bare Root Shrubs	18 inches	—	18	10
	2 ft	—	20	10
	3 ft	—	24	12
	4 ft	—.	28	12
Vines	SIZE			
	2-1/4 inch Peat Pot		12	6
	3 inch Peat Pot or Container		18	6
	4 inch Container		18	8
	No. 1 Container		18	8

3.3 PLANT STORAGE AND HANDLING

a. The Contractor shall provide adequate facilities for the protection, watering and temporary storage of plant materials.

b. Materials shall be protected from damage.

2.

3. Balled and burlapped (B&B) root balls shall be kept moist at all times. If not planted within seven (7) days of delivery to the site, root balls shall be covered with mulch or straw and kept watered until planting.

4. Container material shall be watered continuously.

3.4 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. The Contractor shall perform all planting, fertilizing, supporting, pruning, mulching and initial watering operations conforming to the following:

1. General: Plants shall be placed in planting pits in a vertical position with the root collars exposed at the proper height as specified below. Amended soil shall be placed under and around roots to stabilize them in position. The root collars shall be placed at the following levels:

a. For wet, poorly drained soils, approved topsoil mixed with twenty percent (20%) by volume of compost or other approved organic soil amendments, shall be placed on top of the planting pit and tapered to the existing grade at the edge of the planting pit as specified in the Contract Documents.

TYPE OF SOIL	COLLAR HEIGHT
Well Drained	Same level as the existing grade
Compacted	1 to 2 inches above the existing grade
Wet, Poorly Drained	25 percent of root mass above the existing grade

b. The burlap on the tops of plant balls shall be loosened and cut away from the entire top portion of the plant ball. When wire baskets are used, they shall be removed at planting. Containers shall be removed from the root mass of container grown plants and the fibrous roots loosened around the perimeter of the ball. Amended soil for all plants shall be lightly compressed to eliminate major air pockets. Planting soil shall be thoroughly saturated with water during the planting process to settle soil, eliminate air pockets and to provide for initial water needs of the plants.
c. During the planting process, fertilizer tablets or other approved slow release fertilizers shall be placed around plant roots in conformance with the manufacturer's recommendations.
d. Care shall be taken during the backfilling, soil compressing and watering to avoid injuring the roots.
e. Individually planted trees and shrubs shall have a four inch (4") high berm of excavated soil or mulch placed outside the rim of the pit to form a saucer. Plants on slopes four to one (4:1) and steeper shall have soil excavated from the uphill rim of the pit and a berm built on the downhill rim.
f. Plants in beds, except trees, will not require berms. A four inch (4") high shoulder of excavated soil shall be placed at the lower edge of all beds on slopes four to one (4: 1) and steeper.
g. Berms and shoulders for planting shall be compacted and graded to the satisfaction of the Architect and Tree Protection Expert.

D. Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Backfill: Planting soil For trees, use excavated soil for backfill.
2. Balled and Burlapped Stock: 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.
3. Balled and Potted and Container-Grown Stock: Carefully remove root ball from container without damaging root ball or plant.

4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Bare-Root Stock: Support stem of each plant and spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working. Carefully work backfill around roots by hand. Bring roots into close contact with the soil.
6. 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.
7. 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 (25 mm) from root tips; do not place tablets in bottom of the hole.

    a. Bare-Root Stock: Place tablets beside soil-covered roots; do not place tablets touching the roots.
    b. Quantity: Three for each caliper inch of plant.

8. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. 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.

3.5 SPADE HARVESTED AND TRANSPLANTED TREES

A. Spade Harvested and Transplanted Plants shall meet all the requirements for field grown trees. Root ball diameters shall be of similar size as the ANSI Z60.1 requirements for Balled and Burlapped plants.

B. Trees shall be harvested prior to leafing out (bud break) in the spring or during the fall planting period except for plants know to be considered as fall planting hazards. Plants that are fall planting hazards shall only be harvested prior to leafing out in the spring.

C. Do not excavate tree pits more than 24 hours prior to transplanting.

D. Trees shall be moved and planted within 48 hours of the initial harvesting and shall remain in the spade machine until planted.

E. Preparation
1. Verify with Owner all plants to be transplanted prior to beginning work.
2. Stake plant layout for adjustment and approval by Architect prior to transplanting.
3. Transplant all plantings as shown on Drawings. Proceed with transplanting operations based upon Owner accepted schedule and methods.

4. Use the same machine to dig receiving hole and to dig tree for transplanting.
5. Use machinery in good condition with a minimum tolerance (max 2") between cutting blades. All blades shall be true to their designed shape and free of bends, which could interfere with their operation. Mount tree spade on a suitable stable machine capable of supporting the weight of all removed material and heavy enough to force the blades into the soil.
6. Spray trunks with Lindane or Dursban for control of borers and wrap hardwoods to first branch.

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 Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by 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 STAKING AND GUYING

A. Shade trees specified at six feet (6') high, flowering trees specified at three-quarters inch (3/4") in caliper and evergreen trees specified at five feet (5') high or greater sizes shall require supports. Other trees shall be supported as specified in the Contract Documents and as follows:

STOCK	CALIPER inches	HEIGHT feet	SUPPORT REQUIRED
Shade Trees	—	6	2 stakes 6 ft length
	3/4 to 2	—	2 stakes 8 ft length
	2-1/2 to 3-1/2	—	3 stakes 10 ft length
	4 and over	—	3 guy wires attached to approved tree anchors
Flowering Trees	3/4 to 2-1/2	—	2 stakes 5 to 8 ft length as required
	3 and over	—	3 guy wires attached to approved tree anchors
Evergreen Trees	—	5 and 6	2 stakes 5 to 6 ft length as required
	—	7, 8 and 9	3 stakes 7 to 8 ft length as required
	—	10 and over	3 guy wires attached to approved tree anchors

1. When driving stakes and installing anchors, trees shall not be damaged. Each stake shall be

positioned five inches to eight inches (5" to 8") away from the edge of the ball and driven into solid bearing ground to a minimum depth of ten inches (10") or more below the bottom of the pit to support the plant. After stakes are driven, they shall be vertical. Stakes and guys shall support trees in a vertical position. All tree staking and guying shall be completed the same day as planting.

2. Staking and guying shall be performed as specified in the Contract Documents or as directed by the Architect.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines 9 inches (225 mm) apart in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. 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 12 inches (300mm) 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 2-inch (50-mm) average thickness, with 24-inch (600-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) average thickness of organic mulch extending 12 inches (300 mm) 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 (75 mm) of trunks or stems.

3.10 EDGING INSTALLATION

A. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge.

3.11 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree. Fill each device with water and maintain in a continuously filled condition for the term of the Contractor's maintenance requirement.

3.12 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, 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.

D. 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.

E. 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.

F. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.13 CONSTRUCTION PHASE ACCEPTANCE

A. The Contractor shall submit a request to the Architect in writing for acceptance of the Construction phase. The Architect will grant acceptance when the landscape project has been substantially completed and the following requirements are in conformance:
   1. Plant materials show evidence of having been successfully transplanted.
   2. Unacceptable plants have been replaced.
   3. Planting pits and planting beds are weed free.

4. Damaging pests have been controlled.
5. Dead wood has been pruned.
6. Trees have been straightened.
7. Staking and guying have been repaired.
8. Washouts in and around planting pits and beds have been repaired and mulch has been replaced as required.
9. Plants have been watered as necessary.
10. All other required Work has been completed.
11. Landscaping approved by Tree Protection Expert.

3.14 MAINTENANCE SERVICE

A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period for Trees and Shrubs: 24 months from date of Planting Substantial Completion and Architect’s acceptance.

B. Maintenance: The Contractor shall maintain all plants in conformance with the original Specifications and as follows:
1. Additional Watering of Plants: The Contractor shall monitor the water needs of all plants. When the Contractor feels watering is necessary, the Architect shall be notified. If the Engineer concurs, the Contractor shall begin watering immediately. If the Contractor fails to water when and as required, the Architect will notify the Contractor and watering shall begin within -our (24) hours. The Contractor shall continue to water daily until all plant pits in the Contract have been watered unless otherwise directed by the Architect. Each watering shall be completed within seven Calendar Days (7) of the day on which watering was designated to begin. All watering shall be accomplished using a hose with nozzle end breaker or watering probe. Water shall be applied at low water pressure directly to each planting pit, allowing water to be absorbed into the planting pit soil until saturated, but without runoff. "Gator bags" may be used to properly distribute water to plants where approved by Tree Protection Expert.
2. Weed Control: All undesirable vegetation growing within mulched areas shall be eradicated using glyphosate with a wetting agent in conformance with the manufacturer's recommendations. During each growing season, the Architect and the Contractor shall inspect the site on or about May 30, July 15 and August 30 to determine if weed control is acceptable. Eradication shall be performed prior to these inspections. All weeds greater than six inches (6") high shall be cut down and removed from the project. Any remaining live weed growth shall be treated with herbicide until eradicated. All herbicide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. The Contractor shall provide a Certified

Applicator of Pesticides (Category Ill A or VI). Daily herbicide application reports shall be provided to the Architect. The Contractor shall be responsible for replacing and pruning any plant material which is killed or damaged through any act of negligence by the Contractor in applying and handling of the herbicide on the project.

3. Pest Management: The Contractor shall institute an integrated pest management (I PM) Program. The Contractor shall periodically inspect the project for plant pests during each growing season. When potential damaging levels of plant pests are observed, they shall be controlled to prevent damage to the plants.
4. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. The Contractor shall provide a Certified Applicator of Pesticides (Category Ill A or VI). Daily pesticide application reports shall be provided to the Architect.
5. If the Contractor fails to monitor and control plant pests prior to damage, the Contractor will be notified to begin pest control operations within twenty-four (24) hours, until all damaging pests have been controlled.
6. Refertilization: When required and as directed by the Tree Protection Expert, plants shall be fertilized with a solution of 20-20-20 or other approved analysis water soluble fertilizer designed for the liquid fertilization of plants as specified in the manufacturer's recommendations.
7. Tree Support Removal: The Contractor shall remove all tree supports to ground level after one (1) growing season in conformance with the Contract Documents. Stakes shall be removed by cutting or pulling. All stakes, hoses, wires and guys shall be completely removed from the job site and disposed of by the Contractor. Tree support removal shall be performed in the last thirty (30) days of the plant establishment period and prior to Final Acceptance of the project.

C. Removal and Replacement: The Contractor shall promptly remove from the project all unacceptable plants. Plant replacement shall be made as originally specified. All unacceptable plants shall be replaced during each planting season. When between planting seasons, they shall be replaced during the next proper planting season.

D. Final Acceptance: The Contractor shall submit a written request to the Architect for a Final Acceptance of the landscaping on the project.

3.15 PLANT RELOCATION

A. If the Architect or Tree Protection Expert determines that selected locations of plants installed on the project are undesirable, the plants shall be relocated as directed by the Architect or Tree Protection Expert. When directed, the Contractor shall begin removing plants within five (5) working days and continue daily relocation operations until Work is complete. Backfilling of abandoned planting pits shall conform to planting pits article.

3.16 ABANDONED PLANTING PITS

A. When the Architect directs that an excavated plant pit be abandoned, the Contractor shall backfill the pit with the excavated soil or approved backfill. The backfill shall be compacted in eight inch (8") layers to the finished grade. Preparation and seeding of the disturbed area shall conform to 32 92 23.01, (Turf Establishment).

END OF SECTION

SECTION 33 10 00 WATER UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 SUMMARY

A. This Section includes water systems piping for potable water service and fire protection service outside the building.

B. Related Specifications: The following standard specifications are made a part of this specification to the extent referenced herein.

1. National Fire Protection Association "Standard for Installation of Private Fire Supply Mains and Their Appurtenances - NFPA 24".

C. Related Sections:

1. Section 312300: Excavating and Filling.
2. Refer to sections relating to fire protections systems and water distribution systems in Division 22.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Pressure Rating: Except where otherwise indicated, the following are minimum pressure requirements for water system piping.

1. Underground Piping: 280 psig with an actual operating pressure of 125 psig.
2. All materials shall be in accordance with the requirements of the Baltimore City Plumbing Code and the Baltimore City Department of Public Works.

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division I

Specification Sections.

B. Product data for the following:

1. Identification materials and devices.

C. Coordination drawings showing pipe sizes and elevations. Include details for connections, anchors, and reaction backing. Show other piping in same trench and clearances from water system piping. Indicate interface and spatial relationship between piping and proximate structures.

D. Record drawings at Project closeout of installed water system piping and products according to Division 1 Section "Project Closeout".

E. Test reports specified in "Field Quality Control" Article in Part 3.

1.5 QUALITY ASSURANCE

A. Comply with standards of authorities having jurisdiction for fire protection systems. Include materials, hose threads, installation, and testing.

B. Comply with standards of authorities having jurisdiction for potable water piping and plumbing systems. Include materials, installation, testing, and disinfection.

C. Comply with NFPA 24 "Standards for the Installation of Private Fire Service Mains and Their Appurtenances" for materials, installations, tests and flushing.

D. Listing and Labeling: Provide equipment and accessories that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Product Options: Water systems specialties and accessories are based on specific types, manufacturers, and model indicated. Components by other manufacturers but having equal performance characteristics may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by Architect. The burden of proof of equality of products is on Contractor. Refer to Division 1 Section "Product Substitutions."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling, to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Site Information: Data in subsurface investigation repots was used for the basis of the design. The data in the subsurface investigation report is not a part of the Contract. Conditions are not intended as representations or warranties of accuracy or continuity between soil bores. The Owner, Architect or Engineer will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1. Additional test bores and other exploratory operations may be performed by the Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

B. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided. If existing utilities are indicated to be abandoned, the Contractor shall remove such utility, if necessary, at no additional cost to the Owner.

1. Provide a minimum 48-hours notice to the Architect and receive written notice to proceed before interrupting any utility.

C. Should uncharted or incorrectly charted, piping, or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

D. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Open trench excavations within the limits of the State right-of-way shall be protected in accordance with the requirements of applicable permits. Open excavation within other roadways shall be plated and shall be posted with warning devices in accordance with the Manual on Uniform Traffic Control Devices.

1. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.
2. Work which affects the public right-of-way shall be in accordance with the Baltimore City Department of Public Works requirements and regulations.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with pipe materials, sizes, entry locations, and pressure requirements of building fire protection systems piping.

B. Coordinate with pipe materials, sizes, and entry locations, and pressure requirements of building water distribution systems piping.

C. Coordinate with other utility work.

D. Coordinate electrical requirements of actual equipment furnished with requirements specified in Division 26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with the requirements of Baltimore City, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

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

1. Drilling Machine Corporation Stops:
    a. Ford Meter Box Co., Inc.
    b. Hays Div., Romac Industries.
    c. Mueller Co., Grinnell Corp.
2. Bronze Corporation Stops and Valves:
    a. Ford Meter Box Co., Inc.
    b. Hays Div., Romac Industries.
    c. A.Y. McDonald Mfg. Co.
    d. Mueller Co., Grinnell Corp.
3. Tapping Valves:
    a. A.P. Smith Manufacturing Company.
    b. M & H Valve & Fittings Company
4. Gate Valves:
    a. A.P. Smith Manufacturing Company.
    b. M & H Valve & Fittings Company.
5. Dry-Barrel Fire Hydrants:
    a. American Darling Valve Company Model B-62-B
    b. Dresser Manufacturing Company Reliant Style 929
    c. Kennedy Valve Company Guardian Model K-81

e. Mueller Co. A-463 Centurian
f. U.S. Pipe & Foundry Co. Smith Model H 205

6. Drains:
   a. Ancon, Inc.
   b. Jones Manufacturing Co., Inc.
   c. Josam Co.
   d. Jay R. Smith Mfg. Co. Div., Smith Industries, Inc.
   e. Wade Div., Tyler Pipe Subsid., Tyler Corp.
   f. Zurn Hydromechanics Div., Zurn Industries, Inc.
7. Detector Check Valves:
   a. Ames Co., Inc.
   b. Hersey Products, Inc., Grinnell Corp.
   c. Kennedy Valve Div., McWane, Inc.
   d. Viking Corp.
   e. Watts Regulator Co.
8. Backflow Preventers:
   a. Ames Co., Inc.
   b. Cla-Val Co. Div., Griswold Industries.
   c. Conbraco Industries, Inc.
   d. Febco.
   e. Hersey Products, Inc., Grinnell Corp.
   f. Watts Regulator Co.
   g. Wilkins Regulator Div., Zurn Industries, Inc.

2.2 PIPES AND TUBES

A. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube materials specified below are used.

B. Ductile-Iron Pipe: AWWA C151, Class 54.
   1. Lining: AWWA C104, cement mortar, seal coated.
   2. Gaskets, Glands, and Bolts and Nuts: AWWA C111.
   3. Mechanical-Joint-Type Pipe: AWWA C111, rubber gaskets, ductile retain- or glands, and steel bolts and nuts.
   4. Encasement: AWWA C105, polyethylene film tube.

C. Copper Tube: ASTM B 88, Types K (ASTM B 88M, Types A and B), seamless water tube, annealed temper.

2.3 PIPE AND TUBE FITTINGS

A. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube fitting materials specified below are used.

B. Ductile-Iron Pipe Fittings Class D or Class 250: AWWA C110, ductile-iron, 250-psig (1725-kPa) minimum pressure rating; or AWWA C153, ductile-iron compact fittings, 350-

psig (2400-kPa) pressure rating.

1. Lining: AWWA C104, cement mortar.
2. Gaskets: AWWA C111, rubber.

C. Polyethylene Encasement: AWWA C105, 8-mils (2 mm) minimum thickness, tube or sheet.

2.4 JOINING MATERIALS

A. Refer to Part 3 Article "Piping Applications" for identification of systems where joining materials specified below are used.

B. Ductile-Iron Pipe and Ductile-Iron Fittings: The following materials apply:

1. Mechanical Joints: AWWA C111 ductile-iron retainer glands, high-strength steel bolts and nuts, and rubber gaskets.

2.5 PIPING SPECIALTIES

A. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150-psig (1035-kPa) or 300-psig (2070-kPa) minimum pressure to suit system pressures.

B. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 150-psig (1035-kPa) or 300-psig (2070-kPa) minimum working pressure to suit system pressures.

2.6 VALVES

A. Valves shall be in accordance with the latest requirements of Baltimore City and Baltimore City.

B. Valve Boxes: Concrete Sectional Vaults having frame and cover with lettering "Water Valve," in accordance with Baltimore City standards.

C. Tapping Sleeve and Tapping Valve: Shall be in accordance with the latest requirements of Baltimore City and Baltimore City.

D. Service Clamps and Corporation Stops: Complete assembly, including service clamp, corporation stop, and bolts and nuts. Use service clamp and stop compatible with drilling machine.

1. Service Clamp: Cast iron or ductile iron with gasket and AWWA C800 threaded

outlet for corporation stop, and threaded end straps.

2. Corporation Stops: Bronze body and ground key plug, with AWWA C800 threaded inlet and outlet matching service piping material.
3. Manifold: Copper with 2 to 4 inlets as required, with ends matching corporation stops and outlet matching service piping.

2.7 WATER METERS

A. General: Provide water meter with registration in gallons.

B. Domestic Water Meter: As approved by Baltimore City.

C. Fire Service Water Meter: As approved by Baltimore City.

2.8 PITS

A. Concrete: Portland cement mix, 3000 psi (20.7 MPa).
1. Cement: ASTM C 150, Type I.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Reinforcement: Steel conforming to the following:

1. Fabric: ASTM A 185, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60 (ASTM A 615, Grade 400), deformed.
3. Ladder: ASTM A 36 (ASTM A 36M), steel or polyethylene-encased steel steps.
4. Manhole: ASTM A 48, Class 35, gray-iron, 24-inch (610-mm) minimum diameter traffic frame and cover, of size and weight indicated.
5. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron, 24-inch (610-mm) minimum diameter traffic frame and cover, of size and weight indicated.
6. Drain: ASME A112.21.1M, cast-iron area drain, of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.9 FIRE HYDRANTS

A. General: "Traffic Model", cast-iron body, compression-type valve, opening against pressure and closing with pressure, 6-inch (DN 150) mechanical joint inlet, 150-psig (1035-kPa) working pressure.

B. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.

C. Operating and Cap Nuts: Pentagon 1-3/8 inch (3.5 cm) point to flat.

D. Direction of Opening: Open hydrant valve by turning operating nut to the left, or counterclockwise. Show direction of the opening on the bonnet with a raised arrow.

E. Finish: Sherwin Williams, Kem L-F65, E-36, Safety Orange Lead Free Industrial Enamel or approved equal.

F. Dry-Barrel Fire Hydrants: UL 246, FM-approved, two 2-1/2 inch (6.35 cm) and one 4-1/2 inch (11.4 cm) outlets, 5-inch (12.7 cm) min. main valve, drain valve, and 6-inch mechanical joint inlet and a flanged connection on the stand pipe end.

2.10 ANCHORAGES AND BUTTRESSES

A. General: All anchorages and buttresses shall be in conformance with the Baltimore City Specifications and Standard Details.

B. Concrete Reaction Backing: Portland cement mix, 3000 psi.

1. Cement: ASTM C 150, Type I.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable

2.11 IDENTIFICATION

A. Metallic-Lined Plastic Underground Warning Tapes: polyethylene plastic tape with metallic core, 6 inches wide, by 4 mils thick, solid blue in color with continuously printed caption in black letters “CAUTION - WATER LINE BURIED BELOW”.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section 312300.

3.2 SERVICE ENTRANCE PIPING

A. Extend water system piping from the existing public main to a point within 5' of the proposed building.

1. Terminate water system piping from the proposed public main to a point within 5' of the proposed buildings for fire protection.

B. Water distribution systems and fire protection systems are specified in Division 15 Sections. Sleeves and mechanical sleeve seals are specified in Division 15 Section “Basic

Mechanical Materials and Methods".

3.3 PIPING APPLICATIONS

A. Refer to Part 2 of this Section for detailed specifications for pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping in pits and inside building may be joined with flanges or couplings, instead of joints indicated, for grooved-end AWWA-size piping.

B. Use pipe, tube, fittings, and joining methods according to following applications:

1. 4 inches (DN 100) to 8 inches (DN 200): Class D or Class 250, ductile-iron pipe, ductile-iron compact fittings, and mechanical joints with retainer glands.

3.4 JOINT CONSTRUCTION

A. Ductile-Iron Piping Gasketed Joints: Construct joints according to AWWA C600.

B. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.

C. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to valve ends into which pipes are being threaded.

D. Dissimilar Materials Piping Joints: Construct joints using adapters that are compatible with both piping materials, outside diameters, and system working pressure. Refer to "Piping Systems - Common Requirements" Article for joining piping of dissimilar metals.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS:

A. Installation: Installation shall be in accordance with the Baltimore City Specifications; NFPA 24; the Baltimore City Plumbing Code; and the written recommendations of the pipe manufacturer, except that in the case where there are conflicts among the provision of the various installation requirements, the more stringent or restrictive requirements shall govern.

B. General Locations and Arrangements: Drawings indicate general locations and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated except where deviations to layout are approved on coordination drawings.

C. Install components having pressure rating equal to or greater than system rated pressure (200 psig).

D. Install piping free of sags and bends.

E. Install fittings for changes in direction.

F. Piping Connections: Except as otherwise indicated, making piping connections as specified below.

1. Install flanges, in piping 2-1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
2. Install dielectric fittings to connect piping of dissimilar metals.

3.6 PIPING INSTALLATION

A. Comply with requirements of NFPA 24 for materials and installation.

1. Bury piping at minimum depth of 48 inches below finished grade, and not less than 18 inches below average local frost depth.

3.7 ANCHORAGE INSTALLATION:

A. Anchorages: Install anchorages for tees, plugs/caps, and bends. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron Piping: According to AWWA C600.

B. Apply full coat of asphalt or other acceptable corrosion retarding to surfaces of installed ferrous anchorage devices.

C. Anchorage blocks shall be constructed of a poured reinforced concrete pad, which partially encapsulates the fitting and prevents any relative movement between the straight section of the fitting and the branch section.

3.8 IDENTIFICATION INSTALLATION

A. Install continuous plastic underground warning tape during back filling of trench for underground water service piping. Locate 6 inches to 8 inches below finished grade, directly over piping.

3.9 FIELD QUALITY CONTROL

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

B. Hydrostatic Tests: Test at not less than 2 times operating pressure for 2 hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 1000 joints. Remake leaking joints with new materials and repeat test until leakage is within above limits.

3.10 CLEANING

A. Clean and disinfect water distribution piping as follows:

1. Purge new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
2. Use purging and disinfecting procedures prescribed by Baltimore City Specifications and NFPA.

B. Prepare reports for purging and disinfecting activities.

END OF SECTION

SECTION 33 30 00 – SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 SUMMARY

A. This Section includes sewage disposal systems.

B. Related Sections:
1. Section 312300; Excavating and Filling.
2. Section 033300; Cast-In-Place Concrete.
3. Refer to sections relating to plumbing piping and drainage and vent systems in Division 22.

1.3 DEFINITIONS

A. Wastewater: Sewage, water or other liquid requiring disposal.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Solid Piping Rating: At least equal to system operating pressure.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Shop drawings for the following precast, reinforced concrete structures, including manhole openings, covers, pipe connections, and accessories.

C. Coordination drawings showing piping, underground structures, and other utilities. Indicate size and invert elevations of piping and structures.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the local health department and authorities having jurisdiction.

B. Product Options: Drawings indicate sizes, profiles, connections and dimensional requirements of septic system components. Manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Product Substitutions."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe or fittings in direct sunlight.

B. Protect pipe, pipefittings, and seals from dirt and damage.

C. Handle pre-cast concrete structures according to manufacturers rigging instructions.

1.8 PROJECT CONDITIONS

A. Site Information Data in subsurface investigation reports was used for the basis of the design. The data in the subsurface investigation report is not a part of the Contract. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. The Owner, Architect or Engineers will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1. Additional test borings and other exploratory operations may be performed by the Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

B. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided. If existing utilities are indicated to be abandoned, the Contractor shall remove such utility, if necessary, at no additional cost to the Owner.

1. Provide a minimum 48-hours notice to the Architect and receive written notice to proceed before interrupting any utility.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Refer to Part 3 "Piping Applications" Article for identification of systems where piping materials specified below are used.

B. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D 3034, SDR 26, nonperforated, for solvent-cement or elastomeric gasket joints.

1. Solvent Cement: ASTM D 2564.
2. Gaskets: ASTM F 477, elastomeric seal.

C. Sleeve-Type Couplings: Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

1. Sleeves for Plastic Pipe: ASTM F 477, elastomeric seal.
2. Bands: Stainless steel, at least one at each pipe insert.

D. Gasket-Type Couplings: Rubber or elastomeric compression gasket, made to match outside diameter of smaller pipe and inside diameter or hub or adjoining larger pipe.

1. Gaskets for Plastic Pipe: ASTM F 477, elastomeric seal.
2. Gaskets for Dissimilar Pipes: Compatible with pipe materials being joined.

2.2 CLEANOUTS

A. Description: ASME A112.36.2M, with round, flanged, cast-iron housing, and secured scoriated, medium-dry loading class, cast-iron cover. Include cast-iron ferrule and countersunk brass cleanout plug.

2.3 MANHOLES

A. Precast Concrete Manholes: ASTM C 478, precast reinforce concrete, of depth indicated, with provision for rubber gasket joints, and frame and cover; all in accordance with Baltimore City Standard Details. Include indented top design with lettering, equivalent to the following cast into cover:

1. Sanitary Sewer Piping Systems: Sanitary Sewer

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section 312300 – "Excavating and Filling".

3.2 IDENTIFICATION

A. Identification materials and their installation are specified in Division 31 Section "Excavating and Filling". Arrange for installation of green warning tapes directly over piping (including absorption field piping), at outside edges of underground structures, and at outside edges of seepage pits.

1. Use detectable warning tape over edges of underground structures, edges of seepage

pits, and over nonferrous piping.

3.3 GENERAL INSTALLATION

A. Installation: Installation shall be in accordance with the requirements of the Baltimore City Specifications, and in accordance with the Drawings.

B. Where installation details are not shown on the Drawings, installation shall be in accordance with the Baltimore City Standard Details.

C. Termination: Terminate piping 5' from building foundation in location as indicated. Provide temporary pipe plug for piping extension into building by work of Division 22.

3.4 PIPING APPLICATIONS

A. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below.

B. Use pipe, tube, fittings, and joining methods according to the following applications.

1. Solid Piping: Polyvinyl Chloride (PVC), non-perforated sewer pipe and fittings and solvent-cemented or gasketed joints.

3.5 PIPE JOINT CONSTRUCTION AND INSTALLATION

A Join and install polyvinyl chloride (PVC) pipe as follows:

1. Join solvent-cement type pipe and fitting with solvent cement according to ASTM D 2855 and ASTM F402.
2. Join gasketed pipe and fittings with elastromeric seals according to ASTM D 3212.
3. Install solid piping according to ASTM D 2321.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and extension for mapping to cleanout at grade as indicated. Set cleanout housing and cover in concrete block 18 by 18 by 12 inches deep, except where location is in concrete paving. Set top of cleanout 1 inch above surrounding earth grade, or flush with grade when installed in paving.

B. Cleanout installed in paving shall have countersunk lid.

C. Refer to Division 3 Section “Cast-in-Place Concrete” for formwork, reinforcing and concrete.

3.7 CONNECTIONS

A. Install standard manhole over existing sanitary sewer and connect proposed sanitary.

3.8 FIELD QUALITY CONTROL

A. System Tests: After installation, pipe shall be inspected visually for deflections and misaligned pipe sections.

1. All sewers shall be tested in accordance with Section 1007 of the Baltimore City Specifications, except that Contractor shall supply all materials needed for testing.
2. Additional Tests: Fill underground structures with water and let stand overnight. If water level recedes, locate and repair leaks and retest. Repeat tests and repair until there is no leakage.
3. Cleaning: Clear interior of piping and structures of dirt and other superfluous materials as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.

END OF SECTION

SECTION 33 40 00 - STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the General Provisions apply to all work under this section.

B. Baltimore City Department of Public Works Standard Details for Construction dated March 2008 and as amended.

C. Throughout the specifications, types of materials may be specified by manufacturer's name and catalogue number in order to establish standards of quality and performance and not for the purpose of limiting competition. Alternate methods and/or materials may be submitted to the Architect for consideration. Those judged to be equal to that specified will receive written approval.

1.2 SUMMARY

A. This Section includes drainage systems five feet (5') outside the building. Systems include the following:

1. Storm drainage
2. Stormwater Management Facility

B. Related Sections:

1. Section 312300; Excavating and Filling.
2. Refer to sections relating to plumbing piping, drainage and vent systems and laboratory systems in Division 22.

1.3 DEFINITIONS

A. Drainage Piping: System of sewer pipe, fittings, and appurtenances for gravity flow of storm drainage.

1.4 PERFORMANCE REQUIREMENTS:

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

B. Stormwater Management Permit: Stormwater management facilities shall be constructed in accordance with the approved drawings and the provisions of the Stormwater Management Permit. The Owner will obtain the Stormwater Management Permit prior to construction of the facility.

C. Certification of Completed Facilities: As-Built Plans and Certifications are required for the stormwater management facilities. In order to properly prepare these documents, this stormwater management facility must be inspected by a Registered Professional Engineer at specific stages of the construction. The Contractor shall notify the Owner at least five (5) working days prior to starting work on this stormwater management facility. The Contractor shall provide an As-built survey of the stormwater management facility signed

and sealed by a Registered Surveyor. Preparation and processing of the As-Built Plans and Certification will be the responsibility of the Owner.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for the following:

1. Cleanouts.

C. Shop drawings for precast concrete manholes and other structures. Include frames, covers and grates.

D. Shop drawings for the various types of piping.

E. Shop drawings for cast-in-place concrete or field-erected masonry manholes and other structures. Include frames, covers and grates.

F. Reports and calculations for design mixes for each class of cast-in-place concrete.

G. Inspection and test reports specified in the "Field Quality Control" Article.

1.6 QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.

B. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.

C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Product Substitutions".

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures in direct sunlight.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, pipefittings, and seals from dirt and damage.

D. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

E. Stone to be delivered and placed immediately in the water quality facility and protected from soil contamination.

1.8 PROJECT CONDITIONS

A. Site Information: Data in subsurface investigation reports was used for the basis of the design. The data in the subsurface investigation report is not a part of the Contract. Conditions are not intended as presentations or warranties of accuracy or continuity between soil borings. The Owner, Architect or Engineers will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1. Additional test borings and other exploratory operations may be performed by the Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect's written permission.

D. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate with interior building drainage systems.

B. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cleanouts
   a. Ancon, Inc.
   b. Jones Manufacturing Co., Inc.
   c. Josam Co.
   d. Rockford Sanitary Systems, Inc.
   e. Jay R. Smith Mfg. Co. Div., Smith Industries, Inc.
   f. Wade Div., Tyler Corp.
   g. Zurn Industries, Inc., Hydromechanics Div.

2.2 PIPES AND FITTINGS

A. High Density Polyethylene (HDPE) Pipe and Fittings Hancor Blue Seal Water Tight: As manufactured by Advanced Drainage Systems, Inc. or approved equal.

B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class IV, Wall B, for gasketed joints.

1. Gaskets: ASTM C 443, rubber.

C. High Density Polyethylene (HDPE) perforated pipe and fittings. Fittings Hancor Blue Seal Water Tight, as manufactured by Advanced Drainage Systems, Inc. or approved equal.

2.3 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined, for Nonpressure joints.

1. Sleeves for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.

2. Sleeves for Plastic Pipe: ASTM F 477, elastomeric seal.

3. Sleeves for Dissimilar Pipes: Compatible with pipe materials being joined.

4. Bands: Stainless steel, at least one at each pipe insert.

2.4 MANHOLES

A. Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints, and frame and cover, all in accordance with Baltimore City Standard Details. Include indented top design with lettering, equivalent to the following, cast into cover:

1. Storm Drainage Piping Systems: “STORM DRAIN”.

2.5 STORM DRAIN INLETS

A. General: Pre-cast reinforced concrete, or cast-in-place concrete complete with frames and grates, all in accordance with Baltimore City Standard Details unless otherwise noted on the contract drawings.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Structures: Portland-cement design mix, 4000 psi minimum, with 0.45 maximum water-cement ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

C. Structure Channels and Benches: Factory or held formed from concrete. Portland-cement design mix, 4000-psi minimum, with 0.45 maximum water-cement ratio.

1. Include channels and benches in manholes.
   a. Manholes Channels: Concrete invert, formed to same width as connected piping, with height of the vertical sides to 3/4 of the pipe diameter. Form curved channels with smooth, uniform radius and slope.
      (1) Invert Slope: 2.5 percent (1:40) through manhole.
      (2) Manhole Benches: Concrete, sloped to drain into channel.
         (a) Slope: 1 inch per foot (1:12).
   b. Include channels and benches in storm drain inlets.
      (1) Storm Drain Inlet Channels: Concrete invert, formed to same width as connected piping, with height of the vertical sides to 3/4 of the pipe diameter. Form curved channels with smooth, uniform radius and slope.
         (a) Invert Slope: 2.5 percent (1:40) through inlet.
      (2) Storm Drain Inlet Benches: Concrete, sloped to drain into channel.
         (b) Slope: 1 inch per foot (1:12).
2. Ballast and Pipe Supports: Portland-cement design mix, 3000-psi minimum, with 0.58 maximum water-cement ratio.
   a. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   b. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.7 PROTECTIVE COATINGS

A. General: Include factory - or field-applied protective coatings to structures and appurtenances according to the following:

B. Coating: Apply 2-coats, coal-tar epoxy, 15-mil minimum thickness, except where otherwise indicated.

1. Manholes: On exterior surfaces.
2. Storm Drain Inlets: On exterior surfaces.

2.8 CLEANOUTS

A. Description: ASME A112.36.2M, round, cast-iron housing with clamping device and found, secured, scoriated, cast-iron cover. Include cast-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:

1. Light Duty: In earth or grass, foot-traffic areas.
2. Medium Duty: In paved, foot-traffic areas.
3. Heavy Duty: In vehicle-traffic service areas.

B. Pipe Fitting and Riser to Cleanout: ASTM A 74, service class, cast-iron soil pipe and fittings.

2.9 RIPRAP

A. Stone for riprap shall be uniformly graded from the smallest to the largest pieces as specified in the Contract Documents. The stone will be accepted upon visual inspection at the point of usage, and shall conform to the following:

CLASS OF RIPRAP	WEIGHT RANGES lb (kg)	APPROX. SIZE in. (mm)
0	1-33 (0.5 – 15)	2-7 (50-175)
I	2-150 (1-70)	3-12 (75-300)
II	20-700 (10-320)	6-20 (150-500)
III	40-2000 (20-910)	8-28 (200-700)

2.10 GEOTEXTILES

A. Geotextiles shall conform to the class specified in the Contract Documents. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum 85 percent by weight of polyolephins, polyesters or polyamides. The geotextile shall resist deterioration from ultraviolet exposure. Geotextiles used in the construction of silt fence shall contain sufficient amounts of ultraviolet ray inhibitors and stabilizers to provide a minimum of 12 months of expected usable construction life at a temperature range of 0 to 120F (-18 to 49 C).

B. All values specified are minimum or maximum roll values.

C. Classes A through E Geotextiles shall have a 0.010 cm/sec minimum permeability when tested in conformance with D4491, and an apparent minimum elongation of 20 percent when tested for conformance with the grab tensile strength requirements specified below. Classes A through E Geotextiles shall also conform to the following additional requirements:

GEOTEXTILE CLASS	MAXIMUM APPARENT OPENING SIZE mm	GRAB TENSILE STRENGTH lb (N) min	MINIMUM BURST STRENGTH psi (MPa)
A	0.30	250 (1110)	500 (3.4)

B	0.60	200 (890)	320 (2.2)
C	0.30	200 (890)	320 (2.2)
D	0.60	90 (400)	145 (1.0)
E	0.30	90 (400)	145 (1.0)

D. Class F Geotextiles (Silt Fence) shall have a 50 lb/in. (8.8kN/m) minimum tensile strength and a 20 lb/in. (3.5kN/m) minimum tensile modulus when tested in conformance with D4595. The material shall also have a 0.3 gal/ft² (12.21/m²) per minute minimum flow rate and a 75 percent minimum filtering efficiency when tested in conformance with D 5141.

E. The properties shall be determined as follows:

TEST	METHOD
Apparent Opening Size	D 4751
Grab Tensile Strength	D 4632, Grab Test – 4 x 8 in. (100 x 200 mm) specimen, 1 x 2 in. (25 x 50 mm) clamps; 12 in. (300 mm)/minute strain rate both principal directions of geotextile.
Burst Strength	D 3786

Sewing of the geotextile will be allowed provided it conforms to the following:

a) Seams shall be either "J" or "butterfly" type and shall utilize a lock stitch.
b) Seams shall conform to the tensile strength requirements for the geotextile when tested across the seam.
c) The thread for seaming shall be of equal or greater durability than the geotextile itself.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section 312300- "Excavating and Filling".

3.2 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section 312300. Arrange for installation of green detectable warning tapes directly over piping and at outside edges of underground structures.

3.3 PIPING APPLICATIONS

A. General: Include watertight, silttight, or soiltight joints, except where watertight or silttight joints are indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following applications.

C. Corrugated Polyethylene (HDPE), Hancor Blue Seal corrugated polyethylene pipe installed per manufacturers' specifications.

C. Reinforced-concrete sewer pipe and fittings; rubber gaskets; and gasketed joints.

3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for nonpressure applications:
   a. Strait-pattern, sleeve type to join piping, of same size, with small difference in outside diameters.
   b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
   c. Gasket type to join piping of different sizes where annular space between smaller piping's outside diameter and larger piping's inside diameter permits installation.
   d. Internal-expansion type to join piping with same inside diameter.

B. Special Pipe Fittings: Use where indicated.

3.5 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical and in accordance with the requirements of the Baltimore City Specifications and in accordance with the pipe manufacturer's written instructions. Where installation details are not shown on the Drawings, installation shall be in accordance with the Baltimore City Standard Details.

B. Install piping beginning at low point of systems, 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 recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited, except as indicated on the plans.

E. Install piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

F. Extend piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Install piping pitched down in direction of flow, at minimum slope of 1 percent (1:100) and 36-inch minimum cover, except where otherwise indicated.

3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to the following.

B. Corrugated Polyethylene (HDPE) Plastic Pipe and Fittings: Join and install in accordance with manufacturer's instructions.

C. Concrete Pipe and Fittings: Install according to ACPA "Concrete Pipe Handbook". Use the following seals:

1. Round Pipe and Fittings: ASTM C 443 (ASTM C 443M), rubber gaskets.

D. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems materials and dimensions.

3.7 MANHOLE INSTALLATION

A. General: Install manholes, complete with accessories, as indicated.

B. Form continuous concrete channels and benches between inlets and outlet, where indicated.

C. Set tops of frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches above finished surface elsewhere, except where otherwise indicated.

D. Place precast concrete manhole sections as indicated, and install according to ASTM C 891.

1. Provide rubber joint gasket complying with ASTM C 443, at joints of sections.
2. Apply bituminous mastic coating at joints of sections.

E. Construct cast-in-place manholes as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318, ACI 350R, and as indicated.

3.9 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

B. Set cleanout frames and covers in concrete paving with tops flush with Surface of paving.

C. Cleanouts located in paving shall have countersunk lids.

3.10 CLOSING ABANDONED DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping that is 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 of the following procedures:

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 Structures: Excavate around structure as required and use either of the following procedures:

1. Remove structure and close open ends of remaining piping.
2. Remove top of 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.
3. Backfill to grade according to Division 2 Section 02300- "Excavation, Filling & Grading".

3.11 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and whenever work stops.
3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. 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 the 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 visual between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
   c. 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 procedures until results are satisfactory.

C. 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 authorities having jurisdiction.
3. Schedule tests, and their inspections by authorities having jurisdiction, with at least 24 hours advance notice.
4. Submit separate reports for each test.
5. High density polyethylene "HDPE" pipe: Perform testing in accordance with manufacuturers recommendations.
6. Where authorities having jurisdiction do not have published procedures, perform tests as follows:
    a. Storm Drainage: Perform hydrostatic test.
        (1) Allowable leakage is a maximum of 200 gallons per inch nominal pipe size, for every mile of pipe, during a 24-hour period.
        (2) Close openings in system and fill with water.
        (3) Purge air and refill with water.
        (4) Disconnect water supply.
        (5) Test and inspect joints for leaks.
        (6) Option: Test ductile-iron piping according to AWWA C600, Section 4 "Hydrostatic Testing". Use test pressure of at least 5 psig.
        (7) Option: Test concrete piping according to ASTM C 969.
        (8) Option: Test concrete arch piping and elliptical piping according to authorities having jurisdiction.
    b. Storm Drainage: Perform hydrostatic test. Close openings in system and fill with water to not less than 10-foot head of water. Disconnect water supply. Water level must not drop for 15 minutes. Inspect joints for leaks.
        (1) Option: Test concrete arch piping and elliptical piping according to authorities having jurisdiction.
    c. Storm Drainage: Perform air test according to UNI-B-6.
        (1) Option: Test round concrete piping, 24 inches and smaller, according to ASTM C 924.
        (2) Option: Test concrete arch piping and elliptical piping according to authorities having jurisdiction.
7. Manholes: Perform hydraulic test according to ASTM C 969.
8. Leaks and loss in test pressure constitute defects that must be repaired.
9. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION