GREATER LYNCHBURG TRANSIT COMPANY OPERATIONS AND MAINTENANCE FACILITY

419 BRADLEY DRIVE
LYNCHBURG, VA 24501

Bid Documents

SPECIFICATIONS

Volume 2 of 2

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FIRE SUPRESSION

SECTION 21 0513

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 poly-phase, 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 requirements in this Section except when stricter requirements are specified in fire suppression equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. 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: Pre-lubricated, 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 Used*

END OF SECTION

SECTION 21 0517

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. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. 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 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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 or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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

2.4 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 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 Section 079200 "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 Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE-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 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

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

2. Exterior Concrete Walls below Grade:

   a. 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 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. 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 21 0518

ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated 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-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.

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. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with chrome-plated finish.
e. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or 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.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 21 0523

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. Two-piece ball valves with indicators.
2. Check valves.
3. Bronze OS&Y gate valves.
4. Iron OS&Y gate valves.
5. NRS gate valves.
6. Trim and drain valves.

1.3 DEFINITIONS

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

B. NRS: Non-rising 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, provide products by one of the following:

1. NIBCO INC.
2. Victaulic Company.

B. Description:

1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (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.
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 CHECK VALVES

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

1. Anvil International, Inc.
2. NIBCO INC.

3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Victaulic Company.
6. Viking Corporation.
7. Watts Water Technologies, 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 with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.4 BRONZE OS&Y GATE VALVES

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

1. Milwaukee Valve Company.
2. NIBCO INC.
3. United Brass Works, 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.

2.5 IRON OS&Y GATE VALVES

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

1. Kennedy Valve; a division of McWane, Inc.
2. Mueller Co.; Water Products Division.
3. NIBCO INC.
4. Victaulic Company.

5. Watts Water Technologies, Inc.

B. Description:

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

2.6 NRS GATE VALVES

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

1. Kennedy Valve; a division of McWane, Inc.
2. Mueller Co.; Water Products Division.
3. NIBCO INC.
4. Victaulic Company.

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 or Grooved.

2.7 TRIM AND DRAIN VALVES

A. Ball Valves:

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

a. Fire Protection Products, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Potter Roemer.

e. Tyco Fire & Building Products LP.
f. Victaulic Company.
g. Watts Water Technologies, Inc.

2. Description:

a. Pressure Rating: 175 psig
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

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

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

2. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

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

a. NIBCO INC.
b. United Brass Works, Inc.

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. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

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

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

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

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

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

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

installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION

SECTION 21 0553

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. Valve tags.
5. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

C. 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: Stainless steel, 0.025 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: Stainless Steel

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. 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.

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

C. Background Color: Yellow.

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

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

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-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. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. 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.

D. Pipe-Label Colors:

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

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain or S-hook.
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.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire-link chain.
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 LABEL INSTALLATION

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

D. Locate equipment labels where accessible and visible.

E. 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 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. Wet-Pipe Sprinkler 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 1119

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. Flush-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 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

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

1. American Fire Hose & Cabinet.
2. Guardian Fire Equipment, Inc.
3. Potter Roemer.

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"

N. Finish: Rough bronze.

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

3.2 INSTALLATION

A. Install wall-type fire-department connections.

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

END OF SECTION

SECTION 21 1313

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Manual control stations.
6. Control panels.
7. Pressure gauges.

B. Related Sections:

1. Section 211119 "Fire-Department Connections" for flush-type fire-department connections.
2. Section 213113 "Electric-Drive, Centrifugal Fire Pumps" for fire pumps.
3. Section 213400 “Pressure-Maintenance Pumps” for pressure maintenance pumps.
4. Section 213900 “Controllers for Fire-Pump Drivers” for 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 obtained.

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. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
f. Special Occupancy Hazard: As determined by NFPA 13 and authorities having jurisdiction.

3. Maximum Protection Area per Sprinkler: Per UL listing.
4. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft..
b. Storage Areas: 130 sq. ft..
c. Mechanical Equipment Rooms: 130 sq. ft.
d. Electrical Equipment Rooms: 130 sq. ft.
e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

5. 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
c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes

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. Structural steel
2. Domestic water piping.
3. Compressed air piping.
4. HVAC hydronic piping.
5. Items penetrating finished ceiling include the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.

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. Perform fire-hydrant flow test report, record and submit the following information:

1. Date
2. Time
3. Performed by
4. Location of Residual Fire Hydrant R
5. Location of Flow Fire Hydrant F
6. Static Pressure at Residual Fire Hydrant R (psig)
7. Measured Flow at Flow Fire Hydrant F (gpm)
8. Residual Pressure at Residual Fire Hydrant R (psig)

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 ASME Boiler and Pressure Vessel Code.

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

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

1. NFPA 13, "Installation of Sprinkler Systems."

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

B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 plain end.

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

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

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

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

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

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

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

J. Grooved-Joint, Steel-Pipe Appurtenances:

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

   a. Anvil International, Inc.
   b. National Fittings, Inc.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.

2. 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.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

C. 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 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.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Check Valves:

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

a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.

2. Description: Ductile iron body with rubber-faced clapper hinged to access cover. All moving parts capable of being serviced without removing valve from installed position. External bypass trim with non-interruptible pressure switch to activate remote alarm. Include taps for inlet and outlet pressure gauges, alarm devices and system main drain. Include all trim and alarm test valve.

3. Standard: UL 312 and FM Global's "Approval Guide"

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

2.5 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

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

a. Anvil International, Inc.
b. National Fittings, Inc.
c. Shurjoint Piping Products.
d. Tyco Fire & Building Products LP.

e. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

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

   a. AGF Manufacturing Inc.
   b. Reliable Automatic Sprinkler Co., Inc.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.

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

C. Sprinkler Inspector's Test Fittings:

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

   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.

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

D. Adjustable Drop Nipples:

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

a. CECA, LLC.
b. Corcoran Piping System Co.
c. Merit Manufacturing; a division of Anvil International, Inc.

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

2.6 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. 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. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating and as follows for specific situations(unless otherwise indicated or required by application):

a. Tire Storage – ESFR type sprinklers
b. Rack Storage – Minimum K=11.2
c. Parts Storage – Minimum K=8.0

D. Sprinkler Finishes:

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

E. Special Coatings:

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

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

1. Ceiling Mounting: Plastic, white finish, one piece, flat.

G. Sprinkler Guards:

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

a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

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

B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

C. Water-Flow Indicators:

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

a. ADT Security Services, Inc.
b. McDonnell & Miller; ITT Industries.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
e. Viking Corporation.
f. 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.

D. Pressure Switches:

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

   a. AFAC Inc.
   b. Barksdale, Inc.
   c. Detroit Switch, Inc.
   d. Potter Electric Signal Company.
   e. System Sensor; a Honeywell company.
   f. Tyco Fire & Building Products LP.
   g. United Electric Controls Co.
   h. 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.

E. Valve Supervisory Switches:

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

   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. 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 valve is in other than fully open position.

2.8 PRESSURE GAUGES

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

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.

4. WIKA Instrument Corporation.

B. Standard: UL 393.

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

D. Pressure Gauge Range: 0 to 250 psig minimum.

E. Water System Piping Gauge: Include "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 WATER-SUPPLY CONNECTIONS

A. Install shutoff valve, alarm check valve, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

3.3 PIPING INSTALLATION

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

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

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

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

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

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

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

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

H. Install 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.

I. Install alarm devices in piping systems.

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

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

L. Fill sprinkler system piping with water.

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

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

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

3.4 JOINT CONSTRUCTION

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

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

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

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

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

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

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

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

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

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

3.5 VALVE AND SPECIALTIES INSTALLATION

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

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

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

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Check Valves: Include trim and drain-line connection.

3.6 SPRINKLER INSTALLATION

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

3.7 IDENTIFICATION

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

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

3.8 FIELD QUALITY CONTROL

A. Perform 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.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.10 DEMONSTRATION

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

3.11 PIPING SCHEDULE

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

B. 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, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:

1. 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.
2. [Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:

1. Standard-weight, 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.
2. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

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

1. Rooms without Ceilings: Upright sprinklers unless otherwise indicated.
2. Rooms with Suspended Ceilings: Semi-Recessed sprinklers unless otherwise indicated.
3. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.

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

1. Semi-Recessed Sprinklers: White, with white plastic escutcheon.
2. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
3. Pendent Sprinklers: White in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 21 3113

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. In-line fire pumps.
2. Fire-pump accessories and specialties.
3. Flowmeter systems.

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

B. Source quality-control reports.

C. 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.

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

2.2 IN-LINE FIRE PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. S.A. Armstrong Limited.

B. Pump:

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

    a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.

b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base.

C. Coupling: None or rigid.

D. Driver:

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

E. Capacities and Characteristics:

1. Rated Capacity: 1500 gpm.
2. Total Rated Head: 70 psig.
3. Inlet Flange: Class 125.
4. Outlet Flange: Class 125.
5. Suction Static Head Available at Pump: 56 psig
6. Motor Horsepower: 100
7. Motor Speed: 1775 RPM
8. Electrical Characteristics:

a. Volts: 460
b. Phase: Three.
c. Hertz: 60.

9. Pump-Start, Pressure-Switch Setting: 50 psig (Adjustable).
10. Pump-Stop, Pressure-Switch Setting: 55 psig (Adjustable)

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, provide products by one of 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: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
e. Escutcheon Plate: Brass or bronze; rectangular.
f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
g. Exposed Parts Finish: Rough bronze.
h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 FLOWMETER SYSTEMS

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

1. Emerson Process Management; Rosemount Division.
2. Fire Research Corp.
3. Gerand Engineering Co.
4. Hydro Flow Products, Inc.
5. Hyspan Precision Products, Inc.
6. Meriam Process Technologies.
7. Preso Meters; Division of Racine Federated Inc.
8. Reddy-Buffaloes Pump Company.
9. Victaulic Company.

B. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.

C. Pressure Rating: 175 psig minimum.

D. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.

E. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting.

1. Tubing Package: NPS 1/8 or NPS 1/4 soft copper tubing with copper or brass fittings and valves.

2.5 GROUT

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

B. Characteristics: Non-shrink and recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

2.6 SOURCE QUALITY CONTROL

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

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

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

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 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:

1. Install fire pumps on cast-in-place concrete equipment bases.

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 210523 "General Duty Valves for Fire Protection Piping."

F. Install pressure gauges on fire-pump suction and discharge flange pressure-gauge tappings. Comply with requirements for pressure gauges specified in Section 211313 "Wet-Pipe Sprinkler Systems."

G. Install piping hangers and supports, anchors, valves, gauges, 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 piping connections.

B. 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 211313 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

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

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

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

E. Connect fire pumps to their controllers.

3.5 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 213900 "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. Train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION

SECTION 21 3400

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.

B. Related Section:

1. Division 21 Section "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 MULTISTAGE, PRESSURE-MAINTENANCE PUMPS

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

1. A-C Fire Pump Systems; a business of ITT Industries.
2. Grundfos Management A/S; Grundfos Pumps Corporation U.S.A.
3. PACO Pumps; Grundfos Pumps Corporation U.S.A.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.

C. Pump Construction:

1. Pump Body: Stainless steel.
2. Impellers: Stainless steel, balanced, and keyed to shaft.
3. Diffuser: Stainless Steel.
4. Casing: Stainless Steel
5. Pump Shaft: Stainless steel.
6. Adapter: Cast Iron
7. Base: Aluminum
8. Coupling: Aluminum
9. Seal Plate: Stainless Steel
10. Elastomers: Viton or EPDM
11. Coupling Guard: Stainless Steel
12. Shaft Sleeve and Bushing: Tungsten Carbide
13. Fill/Drain Plugs: Stainless Steel
14. Tie Rods: Carbon Steel, Zinc Plated.
15. Wear Ring: PPS
16. Seal Gland: Stainless Steel

D. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."

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

F. Capacities and Characteristics:

1. Rated Capacity: 15 gpm
2. Total Dynamic Head: 78 psi
3. Working Pressure: 175-psig minimum.
4. Inlet and Outlet Size: NPS 1-1/4.
5. Discharge and Suction Flanges: Class 300
6. Suction Static Head Available at Pump: 56 psi
7. Motor Horsepower: 1
8. Motor Speed: 3500 rpm
9. Electrical Characteristics:

    a. Volts: 480.
    b. Phases: Three.
    c. Hertz: 60.

10. Pump-Start, Pressure-Switch Setting: 57 psig.
11. Pump-Stop, Pressure-Switch Setting: 60 psig.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 21 Section "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.
2. Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

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 Division 03 Section "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 multistage, pressure-maintenance pumps according to HI 1.4.

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 3900

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, full-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 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.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

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

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

D. Source quality-control reports.

E. Field quality-control reports.

1.6 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 Division 01 Section "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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. 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.

1.8 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 Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.9 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.

1.10 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 Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

1.11 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, provide products by one of the following:

1. Aquarius Fluid Products, Inc.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Hubbell Incorporated; Hubbell Industrial Controls.
4. Master Control Systems, Inc.

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: Full Service – Soft Start
3. 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 nonthermal 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 (alarm contact outputs for connection to fire alarm system):

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. Nonautomatic 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 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 nonthermal 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. Nonautomatic (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, provide products by one of the following:

1. Aquarius Fluid Products, Inc.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Hubbell Incorporated; Hubbell Industrial Controls.
4. Master Control Systems, Inc.

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 LOW-SUCTION-SHUTDOWN PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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 or Manual reset.

C. Operation: Integral pressure switch.

D. Supervisory 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.

2.4 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. Outdoor Locations: Type 3R (IEC IP14).
4. Other Wet or Damp, Indoor Locations: Type 4 (IEC IP56).
5. 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.

D. Optional Features:

1. Floor stands, 12 inches high, for floor-mounted controllers.
2. Space heater, 120-V ac, with thermostat.

2.5 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 72 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 Division 26 Section "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 Division 03 Section "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. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Comply with NEMA ICS 15.

3.3 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 Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 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 Division 26 Section "Control-Voltage Electrical Power Cables."

B. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 Section "Digital, Addressable Fire-Alarm System."

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

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

3.5 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 Division 26 Section "Identification for Electrical Systems."

3.6 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 Construction Manager 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 Construction Manager 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.

3.7 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 ADJUSTING

A. Adjust controllers and battery charger systems 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.

3.9 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.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controllers, and to use and reprogram microprocessor-based controls within this equipment.

END OF SECTION

DIVISION 22
PLUMBING

SECTION 22 0500

COMMON WORK RESULTS FOR PLUMBING

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 RELATED SECTIONS

A. Division 01, Sustainable Design Requirements Section 01811313 for credits IEQ 4.1and 4.2.

1.3 SUMMARY

A. This Section includes the following:

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

1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

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

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

F. The following are industry abbreviations for plastic materials:

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

G. The following are industry abbreviations for rubber materials:

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

1.5 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 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.

1.8 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Performance: The product shall meet the listed performance specifications.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
3. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180°F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225°F.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

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

2.7 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

D. Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

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

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Painting" and "High Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 22 0517

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:

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

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

C. 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:

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

C. 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:

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

1. Presealed Systems.

C. 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 Section 079200 "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 Section 078413 "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 Section 076200 "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 Section 078400 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 8: Galvanized-steel wall sleeves.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 8: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel 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.

5. Interior Partitions:

    a. Piping Smaller Than NPS 6: PVC-pipe sleeves.

END OF SECTION

SECTION 22 0518

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.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

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

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons using new materials.

END OF SECTION

SECTION 22 0519

METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes meters and gages for mechanical systems and water meters installed outside the building.

B. Related Sections include the following:

1. Division 2 Section "Natural Gas Distribution" for gas meters outside the building.
2. Mechanical equipment Sections that specify meters and gages as part of factory-fabricated equipment.

1.3 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

B. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Performance: The product shall meet the listed performance specifications.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Domestic Hot Water: 30 to 240ºF, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100ºF, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1.

B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9″ long.

C. Adjustable Joint: Finish to match case, 180º adjustment in vertical plane, 360º adjustment in horizontal plane, with locking device.

D. Tube: Red or blue reading, organic-liquid filled with magnifying lens.

E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

F. Stem: Aluminum or brass for separable socket; of length to suit installation.

2.4 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.
2. Material: Stainless steel, for use in steel piping.
3. Extension-Neck Length: Nominal thickness of 2″, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
4. Insertion Length: To extend to center of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat-Transfer Fluid: Oil or graphite.

2.5 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.

1. Material: Brass, for use in copper piping.
2. Material: Stainless steel, for use in steel piping.
3. Extension-Neck Length: Nominal thickness of 2″, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
4. Insertion Length: To extend to center of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat-Transfer Fluid: Oil or graphite.

2.6 PRESSURE GAGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; liquid-filled-case type.

B. Case: Brass or aluminum with 4″ minimum diameter, glass lens.

C. Connector: Brass, NPS 1/4.

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade A, plus or minus 1% of middle 50% of scale.

F. Range: Comply with the following:

1. Vacuum: 30″ Hg of vacuum to 15 psig of pressure.
2. Fluids under Pressure: Two times the operating pressure.

2.7 PRESSURE-GAGE FITTINGS

A. Valves: NPS 1/4 brass or stainless-steel needle type.

B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: Two self-sealing valves, suitable for inserting 1/8″OD probe from pressure gage.

E. Core Insert: Self-sealing valve, suitable for inserting 1/8″OD probe from pressure gage.

F. Core Material for Air and Water: Minus 30 to plus 275ºF, ethylene-propylene-diene terpolymer rubber.

G. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

H. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.

1. Pressure Gage and Thermometer Ranges: Approximately two times the system's operating conditions.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install remote-reading dial thermometers in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to center of pipe.
2. Fill sockets with oil or graphite and secure caps.

D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.

1. Install with stem extending to center of pipe.
2. Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.

B. Install dry type pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Building water-service entrance.
3. Where indicated on the drawings or specified elsewhere.

C. Install pressure-gage needle valve and snubber in piping to pressure gages.

1. Exception: Install syphon instead of snubber in piping to steam pressure gages.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.

B. Make electrical connections to power supply and electrically operated meters and devices.

C. Ground electrically operated meters.

1. 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 and UL 486B.

D. Install electrical connections for power and devices.

E. Electrical power, wiring, and connections are specified in Division 26 Sections.

3.5 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

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

C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 22 0523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.
   3. Iron gate valves.

B. Related Sections:

   1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
   3. Section 221319 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

1.4 ACTION SUBMITTALS

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

B. Provide valve schedule indicating intended type of valve to be installed and installation location. Refer to valve schedule below.

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 B31.9 for building services piping valves.

C. NSF Compliance: Comply with NSF 61 and NSF 372 for products serving domestic water.

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 ball valves open to minimize exposure of functional surfaces.
4. 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.

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. Handlever: For quarter-turn valves.
2. Hand wheel for gate valves

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

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

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

   a. Conbraco Industries, Inc.; Apollo Valves.
   b. NIBCO INC.
   c. Milwaukee Valve Company.
   d. 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: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. NIBCO INC.
   c. Powell Valves.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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.

2.4 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

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

    a. Milwaukee Valve Company.
    b. NIBCO INC.
    c. Powell Valves.
    d. 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 536, epoxy coated ductile iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: Bronze.
    f. Disc: Ductile iron solid wedge.
    g. Packing and Gasket: Asbestos free.
    h. Operator: Hand wheel

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

C. Install check valves for proper direction of flow and as follows:

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

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.

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 or solder-joint ends.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

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

B. Pipe NPS 2-1/2 and Larger:
1. Ductile iron Gate Valves: Class 125 NRS.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.

END OF SECTION

SECTION 22 0529

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. Metal framing systems.
3. Pipe positioning systems.
4. Thermal-hanger shield inserts.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 METAL FRAMING SYSTEMS

A. Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the

following

a. Anvil International; a subsidiary of Mueller Water Products Inc.
b. Cooper B-Line, Inc.
c. NIBCO INC.
d. Unistrut Corporation; Tyco International, Ltd.

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

2.3 THERMAL-HANGER SHIELD INSERTS

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

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

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

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

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

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

2.4 PIPE 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.

2.5 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

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

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

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

F. 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.

G. 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.

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.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 4: 12 inches long and 0.048 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

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

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.

3.3 ADJUSTING

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

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

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

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

3.5 HANGER AND SUPPORT SCHEDULE

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

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

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

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

E. Use carbon-steel pipe hangers and metal framing systems and attachments for general service applications.

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

G. 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, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

H. 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.

I. 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.

J. 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. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

K. 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.

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

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

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

END OF SECTION

SECTION 22 0553

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. Pipe labels.
3. Stencils.
4. Valve 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. Valve numbering scheme.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch 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.

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

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

2.2 PIPE LABELS

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

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

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

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

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

2.3 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, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
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.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: 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.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

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

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 10 feet along each run.

C. Pipe Label Color Schedule:

1. Domestic Water Piping:

   a. Background Color: Green
   b. Letter Color: White.

2. Sanitary Waste and Storm Drain Piping:

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

3. Gas Piping:

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

4. Compressed Air

   a. Background Color: Blue
   b. Letter Color: White

3.3 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. All: 1-1/2 inches, round.

2. Valve-Tag Color:

   a. All: Natural.

3. Letter Color:

   a. All: Black.

END OF SECTION

SECTION 22 0719

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. Insulation Materials.
   2. Insulating Cements
   3. Adhesives
   4. Mastics
   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. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   3. Detail application of field-applied jackets.

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.

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

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

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," articles for where insulating materials shall be applied.

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

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

D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulated, Division of MFS, Inc; Triple I.
b. P.K. Insulation Mfg. Co, Inc; Super-size.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulated, Division of MFS, Inc; Smooth-cote.
b. P.K. Insulation Mfg. Co, Inc; PK No. 127. Quick-cote
c. Rock wool Manufacturing Company; Delta one shot.

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. 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, provide one of 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.
d. Mon-Eco Industries, Inc.; 22-25.
e. <Insert manufacturer's name; product name or designation>.

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. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of 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.
d. Speedline Corporation; Polyco VP 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: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of 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 (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 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, provide one of 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.
c. Vimasco Corporation; 713 and 714.

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 (Minus 18 to plus 82 deg C).
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM 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.

2.7 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, provide one of the following:

   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

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

2.8 TAPES

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

1. Products: Subject to compliance with requirements, provide one of the following.

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

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

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

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

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of 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 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

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

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

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

a. C & F Wire.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

a. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
b. McGuire Manufacturing.
c. Plumberex.
d. Truebro; a brand of IPS Corporation.
e. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

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. 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. Testing agency labels and stamps.
2. Nameplates and data plates.
3. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

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

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 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, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

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

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

E. 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.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch (25-mm) 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.

3.6 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.7 PIPING INSULATION SCHEDULE, GENERAL

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

1. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.8 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. All pipe sizes: Insulation shall be the following:
   a. Mineral Fiber: 1 inch thick with ASJ.

B. Domestic Hot Water and Recirculated Hot Water:

1. All pipe sizes: Insulation shall be the following:
   a. Mineral Fiber: 1 inch thick with ASJ.

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

1. All Pipe Sizes: Insulation shall be the following:
   a. Protective Shielding Pipe Covers

D. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral Fiber: 1 inch thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral Fiber: 1 inch thick.

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 20 mils thick.

END OF SECTION

SECTION 22 1116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Requirements:

1. Section 221113 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

1.4 Product Data: ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Provide piping schedule indicating type of intended installation and installation location. Refer to piping schedule below.

C. Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼” =1’-0” scale, double lined. Drawings shall indicate pipe layout and elevation, ductwork layout and elevation, and all equipment with manufacturers’ recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items involved: (Submit 3 hard copies of all documents to Architect for Review):

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Piping installation in congested spaces, indicating coordination with general construction, building components, and other building services.
3. Suspended ceiling components.

4. Structural members to which duct will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Penetrations of smoke barriers and fire-rated construction.
7. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

1.5 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.6 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Mueller Industries.
    b. Cambridge-Lee Industries.
    c. Cerro Flow Products

B. Soft Copper Tubing, Annealed Temper: ASTM B 88, Type K.

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

    a. Mueller Industries.
    b. Cambridge-Lee Industries.
    c. Cerro Flow Products

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

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

    a. NIBCO.
    b. Elkhart Products Corporation
    c. Cello Products.

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

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

    a. NIBCO.
    b. Elkhart Products Corporation
    c. Cello Products.

2. MSS SP-123.
3. Cast-copper-alloy, hexagonal-stock body.
4. Ball-and-socket, metal-to-metal seating surfaces.
5. Solder-joint or threaded ends.
6. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
7. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
8. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys.

B. Flux: ASTM B 813, water flushable.

2.4 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. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

    a. Matco-Norca.

b. McDonald, A. Y. Mfg. Co.
c. Watts; a division of Watts Water Technologies, Inc.
d. Wilkins; a Zurn company.

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

C. Dielectric Nipples:

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

a. Elster Perfection Corporation.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.

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

2.5 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. 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.

C. 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.

D. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

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

H. Appurtenances for Grooved-End, Ductile-Iron Pipe:

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

a. Shurjoint Piping Products.
b. Star Pipe Products.
c. Victaulic Company.

2.6 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, [**Type E**] <**Insert type**>, [**Grade B**] <**Insert grade**>, Standard Weight.
2. Include ends matching joining method.

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

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

D. Malleable-Iron Unions:

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

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

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

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

a. Anvil International.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Shurjoint Piping Products.

d. Victaulic Company.

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

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

      1) NPS 8 and Smaller: 600 psig.
      2) NPS 10 and NPS 12: 500 psig.
      3) NPS 14 to NPS 24: 250 psig.

PART 3 - EXECUTION

3.1 EARTHWORK

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

3.2 PIPING INSTALLATION

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

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

C. Install 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 drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

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

E. Install domestic water piping level and plumb.

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

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

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

I. Install piping to permit valve servicing.

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

K. Install piping free of sags and bends.

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

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

N. Install thermometers on inlet and outlet piping from each water heater.

O. Install escutcheons for piping penetrations of walls, and ceilings.

3.3 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.

3.4 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, nipples, or unions.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

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

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

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 3 and NPS 4: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

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

1. NPS 1-1/4 and Smaller: 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: 12 feet with 5/8-inch rod.

3.6 CONNECTIONS

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

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

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

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "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 bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
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. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
7. 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 chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to NYSDOH approved laboratory and results to Architect/Engineer. Repeat procedures if biological examination shows contamination.

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

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

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, piping, NPS 3 and smaller, be the following:

1. Soft copper tube, ASTM B 88, Type K ; wrought-copper, solder-joint fittings; joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; 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 valves for piping NPS 2 and smaller. Use ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.
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 1119

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. Balancing valves.
4. Water mixing valves.
5. Strainers.
6. Wall hydrants.
7. Hose bibbs.
8. Drain valves.
9. Water-hammer arresters.
10. Trap-seal primer devices.

B. Related Requirements:

1. Section 221116 "Domestic Water Piping".

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.

C. Provide valve and hydronic specialties schedule indicating type of intended installation and installation location. Refer to schedule below.

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, provide products by one of the following:

   a. MIFAB, Inc.
   b. Prier Products, Inc.
   c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   d. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

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 plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Conbraco Industries, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.

5. Size: As shown on drawings
6. Body: Bronze
7. End Connections: Threaded and Flanged.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Beverage-Dispensing-Equipment and ice maker Backflow Preventers:

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

    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

C. Hose-Connection Backflow Preventers:

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

    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Woodford Manufacturing Company; a division of WCM Industries, Inc.

2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.5 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

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

    a. MIFAB, Inc.
    b. Prier Products, Inc.
    c. Watts Drainage Products.
    d. Woodford Manufacturing Company; a division of WCM Industries, Inc.
    e. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M for [concealed] [exposed]-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 ¾.
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.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

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

   a. Leonard Valve Company.
   b. Powers; a division of Watts Water Technologies, Inc.
   c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 105 deg F.
9. Tempered-Water Design Flow Rate: 0.5-2.0 gpm.

2.7 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.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

   a. Strainers NPS 2 and Smaller: 0.020 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.8 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: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 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.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Precision Plumbing Products, Inc.
   c. Watts Drainage Products.
   d. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

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.

2.11 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. ProVent Plumbing Systems Inc.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Sure Seal Manufacturing

2. Standard: ASSE 1072-2007.
3. Body: ASB Plastic
4. Diaphragm & Sealing Gasket: Neoprene Rubber
5. Size: Based on floor drain size.
6. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.12 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Precision Plumbing Products, Inc.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

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.

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. Do not install bypass piping around backflow preventers.

B. Install Y-pattern strainers for water on supply side of each pump and where shown on drawings.

C. 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.

D. Install water-hammer arresters in water piping on water piping feeding hand sprayer at three compartment sink.

E. 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.

F. Install trap-seal protection devices during trim out stage of project.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each backflow preventer and pressure vacuum breaker 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 1313

FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections:

1. Section 312000 “EARTH MOVING.”
1. Section 311000 “SITE CLEARING.”
2. Section 312319 “DEWATERING.”
3. Section 033000 “CAST IN PLACE CONCRETE.”

1.2 SUMMARY

A. This section specifies construction of outside, underground sanitary sewer systems, five feet or more outside of the building. The sanitary sewer systems shall be complete and ready for operation, including all structures, frames, and covers, connections to new buildings, structure service lines, existing sanitary sewer lines and existing structures and all required incidentals.

1.3 APPLICABLE PUBLICATIONS AND ABBREVIATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. Virginia Department of Transportation (VDOT) Road and Bridge Specifications

C. Virginia Department of Transportation (VDOT) Road and Bridge Standards.

D. ABREVIATIONS

1. AASHTO American Association of State Highway Transportation Officials
2. ACI American Concrete Institute
3. ACPA American Concrete Pipe Association
4. ANSI American National Standards Institute
5. AREA American Railway Engineers Association
6. ASCE American Society of Civil Engineers
7. ASTM American Society for Testing and Materials
8. CRSI Concrete Reinforcing Steel Institute
9. DIP Ductile Iron Pipe
10. FS Federal Specifications
11. MSDS Material Safety Data Sheets

12. NCMA National Concrete Masonry Association
13. OSHA Occupational Safety and Health Administration
14. RCP Reinforced Concrete Pipe

1.4 SUBMITTALS: Submittals and Certifications: Provide the following in a timely manner in accordance with the approved submittals schedule as specified in Division 1. The Owner reserves the right to review material certifications and reject material that does not match the quality, capacity, construction, performance, appearance, size, arrangement, and general utility and economy of operation of product specifications in this manual.

A. Submit in accordance with Division 01 GENERAL REQUIREMENTS

1. Pipe.
2. Pipe Fittings.
3. Manhole Pipe Connectors.
4. Manholes.
5. Manhole frames and covers.
6. Cleanout frame and covers.
7. Pipe to pipe flexible couplings.

B. Certifications:

1. Concrete Admixture Certification for all precast concrete.
2. Interior protective lining for ductile iron pipe.

1.5 QUALITY ASSURANCE

A. Products Criteria:

1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
2. Manufacturer's name, or identifiable trademark, securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Comply with the rules and regulations of the City of Lynchburg over the connection to public storm sewer lines and the extension, and/or modifications to City of Lynchburg systems.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Pipe Condition/Pipe Examination

1. New Pipe Inspection: Inspect materials thoroughly upon arrival. Examine materials for damage. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications. Check bells and spigots closely for smoothness, roundness, and honeycombing (concrete pipe), which may be a source of infiltration. Check for cracks,

chips, etc. on both ends. Reject any pipe that will not provide watertight seal or is otherwise structurally deficient.

2. Pre-Installation Inspection: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipe damaged or deemed not to conform to these specifications shall be rejected and removed from site. All pipe in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells must be true.

B. Protect pipe coating during handling using methods recommended by the manufacturer. Use of bare cables, chains, hooks, metal bars, or narrow skids in contact with coated pipe is not permitted.

C. Observe manufacturer's directions for delivery and storage of materials and accessories.

D. Protect stored piping from entry of water or dirt into pipe. Protect bells and flanges of special fittings from entry of moisture and dirt.

E. Support pipe to prevent sagging or bending. Do not store plastic pipe, structures, and fittings in direct sunlight.

F. Handle precast concrete manholes and other structures according to manufacturer’s written rigging instructions.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service, unless permitted by the Owner and Engineer, and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

B. Sanitary sewer system improvements and construction operations shall follow Virginia Department of Health and Virginia Department of Environmental Quality standards, including requirements for separation of water mains and sanitary and combined sewer lines. All tie-in connections shall be coordinated with the City of Lynchburg.

C. Parallel Installation:

1. Normal Conditions: Sewer lines and manholes shall be constructed at least 10 feet horizontally from a waterline whenever possible. The distance shall be measured edge-to-edge.
2. Unusual Conditions: When local conditions prevent a horizontal separation of at least 10 feet, then maximum horizontal separation shall be provided with vertical separation of bottom of waterline at least 18 inches above top of sewer. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved ductile iron water pipe pressure-tested in place to 50 psi without leakage prior to backfilling. Sewer

manholes within 10 feet of a waterline shall be of watertight construction, including the frame and cover and leak tested in place.

D. Crossing:

1. Normal Conditions: Sewers crossing under waterlines shall be laid to provide a separation of at least 18 inches between the bottom of the waterline and the top of the sewer whenever possible.
2. Unusual Conditions: When local conditions prevent a vertical separation described in "crossing, normal conditions," paragraph above, the following construction shall be used.

   a. Sewers passing over or under waterlines shall be constructed of cast or ductile iron pipe with mechanical joints as described in "Parallel Installation, Unusual Conditions" above.
   b. Sewers passing over waterlines shall be laid to provide:

      1) Vertical separation of at least 18 inches between bottom of sewer and top of waterline.
      2) Adequate structural support for the sewers to prevent excessive deflection of the joints and settling on and breaking waterline.
      3) Maximum separation of water and sewer line joints.
      4) Sanitary and/or combined sewers or sewer manholes - no water mains/pipes shall pass through or come in contact with any part of a sewer or sewer manhole. Water mains shall be placed at least 10 feet away from any part of a manhole.
      5) No sewer shall pass within 50 feet of a drinking water supply well, source or structure unless special construction and pipe materials are used to obtain adequate protection.

E. Sanitary and/or Combined Sewers or Sewer Manholes – no water mains/pipes shall pass through or come in contact with any part of a sewer or sewer manhole. Water mains shall be placed at least 10 feet away from any part of a manhole.

1.8 COORDINATION

Coordinate tie-ins to municipal sewer mains with the City of Lynchburg Water Resources (Utilities) Engineer.

PART 2 - PRODUCTS

2.1 GRAVITY PIPE

A. Ductile Iron Pipe

Ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA C151/ANSI A21.51 and ASTM A746, Standard Specification for Ductile Iron Gravity Sewer Pipe for 4-inch and larger diameter pipe, thickness class 50 minimum. The thickness of Ductile Iron Pipe shall be determined by considering trench load in accordance with

ANSI/AWWA C150/A21.50. Minimum laying length shall be 18 feet except for tie-in at a structure.

The ductile iron pipe shall be cement mortar lined with a seal coat in accordance with ANSI/AWWA C104/21.4. Hi-Alumina or Protecto 401 shall be used at the specific locations indicated on the drawings or as required by the City Engineer. Outside coat shall be a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.21 Section 51-8.1.

Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, United States Pipe and Foundry Company, Griffin Pipe Products Company, or McWane Cast Iron Pipe Company.

B. PVC PIPE

PVC Solid Wall Sewer Gravity Pipe and Fittings, Bell and Spigot Joints shall comply with ASTM D3034, *Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR 26 minimum (6 inches - 15 inches)*. For 18-, 21-, 24- and 27-inch diameter PVC, SDR 26, comply with the requirements of ASTM F679, *Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings*, or latest revision. Laying lengths shall be a minimum of 12.5 feet for pipes 15 inches or less and 11 feet for the pipes greater than 15 inches. PVC pipe strength shall be capable of withstanding stiffness, flattening, and impact test as scheduled or referenced in ASTM D3034 or ASTM F949. Smooth wall pipe shall have a Standard Dimension Ratio (SDR) of 26 or less. All PVC pipe shall have a minimum pipe stiffness of 46 psi when measured at 5 percent vertical ring deflection and tested in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

C. Concrete Pipe

Reinforced Concrete Pipe less than 42 inches in diameter shall be minimum Class III, Wall B for gasketed joints, meeting ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, according to the depth of cut as specified, AASHTO M 170. Reinforced Concrete Pipe 42 inches and greater in diameter shall be minimum Class III, Wall C for gasketed joints, meeting ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, according to the depth of cut as specified, AASHTO M 170. Pipe shall be of the class as shown on the drawings.

Pipe Testing: The testing of concrete pipe for crushing strength, absorption, hydrostatic requirements, and permeability shall be at the direction of the City Engineer and shall be performed in accordance with ASTM C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

2.2 Jointing Material

A. Ductile Iron Joints and Fittings

Pipe joints may be either push-on or mechanical joint pipe sizes 4 inches through 48 inches in diameter. Rubber Gasket Joints and Mechanical Joints shall comply with AWWA C111/ANSI A21.11, ASTM A536 Standard Specification for Ductile Iron Castings. Acceptable pipe joints are as follows:

Push-on Joint Ductile Iron Pipe shall conform to AWWA C151/ANSI A21.51 (such as "Fastite," "Tyton," or "Bell-Tite."). The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, and comply with AWWAC111/ANSI A21.11.

Fittings shall be ductile iron and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSI 21.53 for compact fittings. All ductile iron fittings shall have a minimum working pressure rating of 250 psi and minimum iron strength of 25,000 psi. All fittings shall be cement mortar lined in accordance with AWWA C104/ ANSI A21.4 and the outside shall be bituminous coated. The fittings shall be tested and the manufacturer shall provide certified test results when requested by the City. This testing shall include hydrostatic proof testing of fittings. Acceptable types of fittings include Push-On Joint and Mechanical Joint.

B. PVC Pipe Joints

Joints for Solid Wall PVC Sewer Gravity Pipe & Fittings and Elastomeric flexible seals (Gaskets) shall be compatible with pipe and shall meet the requirements of ASTM D3212 *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*. Rubber Gaskets shall be used which conform to the requirements of ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

C. Concrete Pipe

Concrete Pipe Joints shall comply with ASTM C443, *Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets*, latest revision.

2.3 PRECAST CONCRETE MANHOLES

A. Manholes of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, or latest revision. Manhole diameters shall be 4-foot minimum. The wall shall be a minimum of 5 inches thick and have a 6-inch minimum base. The standard joint shall be sealed with non-shrink hydraulic cement mortar per VDOT Road and Bridge Specifications, Section 218. A rubber gasket joint seal shall be used and shall conform to the requirements of ASTM C443, *Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets* or latest revision. The gasketed joint shall conform to ASTM C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants* (or AASHTO M-199) or latest revision. Rubber boot and stainless steel clamps, meeting the requirements of ASTM C923, *Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals*, shall be supplied with the manhole bases to tie the pipe to the base section of the manhole. Concrete used in the construction of the manholes shall have a minimum 28-day strength of 4000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33, Standard Specification for Concrete Aggregates and ASTM C94/C94M, *Standard Specification for Ready-Mixed Concrete*. Manhole units shall consist of standard modular precast riser sections, modular riser sections, and a monolithic base (except where doghouse bases are to be used when placing manholes over existing mains). Where conditions do not favorably accommodate the use of an eccentric cone, eccentric precast reinforced concrete flat tops are to be used

Manhole steps are not permitted.

Manholes will be precast reinforced concrete. Drop manholes shall be constructed in accordance with Standard Details 27.04 and 27.05. Interior and exterior drops are permitted on both existing and new manholes. All drop manholes shall have a minimum diameter of 4 feet, with the exception of interior drops on new construction which shall have a 5-foot minimum diameter. Refer to the Standard Details 27.02, 27.03, 27.04, & 27.05 for boot to pipe connection detail. Manholes over 12 feet in depth, as measured from top of casting to effluent invert, shall have extended bases with appropriate reinforcing. .

B. Flexible Pipe-to-Manhole Connector: A flexible Pipe-to-Manhole connector shall be employed in the connection of the sanitary sewer to precast manholes. The connector shall be KOR-N-SEAL, as manufactured by NPC, Inc., Milford, New Hampshire, or approved equal.

The connector shall be the sole element relied on to assure a flexible watertight seal of the pipe to the manhole. No adhesives or lubricants shall be employed in the installation of the connector into the manhole. The rubber for the connector shall comply with ASTM C923 *Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals*, and consist of EPDM and elastomers designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products from spills.

All stainless steel elements of the connector shall be totally non-magnetic Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe, which shall be Series 305 Stainless. The worm screw for tightening the steel band shall be torqued by a breakaway torque wrench set for 60-70 inch/lbs.

The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.

C. Manhole Scour Protection: Scour protection coating shall be fiberglass reinforced polyamine epoxy or elastomeric polyurethane as manufactured by Tnemec, Inc., Kansas City, MO; Carboline Company, Saint Louis, MO; or approved equal.

2.4 MANHOLE FRAMES AND COVERS

A. Standard Frames and Covers: Manhole frames and covers shall be manufactured from Class 30 gray iron, meeting the requirements of ASTM A48, *Standard Specification for Gray Iron Castings*. Standard manhole frames and covers shall be manufactured to the dimensions and configurations shown on Standard Details 27.10 and 27.11 and shall have 4 or 6 1-inch diameter holes in the flange of the frame, as applicable. Minimum inside diameter of the opening shall be 24 inches. Manholes castings may be either bituminous coated or plain. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Covers are to be embossed along the perimeter with the words “Sanitary Sewer.” Approved castings are the US Foundry 710 ring and DP cover, East Jordan Iron Works 2027 frame and cover, or approved equal. (See Standard Details 27.10 & 27.11).

A Vulcan V-1883 is to be used with flat top manholes unless the top of the manhole is less than 1-foot above the 100-year base flood elevation. In that case, a waterproof frame and cover shall be used.

2.5 SERVICES

A. PVC sewer service pipe for sewer services shall be Schedule 40 PVC, ASTM D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120, solvent cement joints (type SC) including the clean-out stack. See Standard Detail 27.15.

Service Saddles: PVC sewer pipe, saddles and adapters shall conform to the requirements of ASTM D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

2.6 STRUCTURE PENETRATIONS

A. Where existing manholes or similar structures are core drilled radially, flexible connections comprised of rubber boots and stainless steel straps, such as Kor-N-Seal, Interpace, or equal shall be furnished. At non-radial penetration locations, Link Seal devices in steel sleeves shall be installed to seal the structure against infiltration.

2.7 CLEANOUT FRAME AND COVER

A. A cleanout frame and cover shall be furnished at each service location. Cleanout frame and cover shall be MH 7621 Capitol Foundry or approved equal.

2.8 MISCELLANEOUS CONCRETE AND CEMENT

A. Concrete Classes (VDOT) to Design Compressive Strength at 28 days (f'c):

Class A4.5	General	4,500 psi
Class A4	General	4,000 psi
Class A3	General	3,000 psi
Class B2	Massive or Lightly Reinforced	2,200 psi

Ready mixed concrete shall comply with ASTM C94, *Standard Specification for Ready-Mixed Concrete*. All exposed concrete shall be air entrained. Concrete strength shall be as specified on standard details and drawings. Unless otherwise specified, all concrete shall be Class A3, minimum.

B. Portland Cement

Type I, CSA normal, ASTM C150 Standard Specification for Portland Cement.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Minimum cover shall be 3 feet or in accordance with the manufacturer’s recommendations, whichever is greater.

E. Install gravity-flow, drainage piping according to the following:

1. Before laying, the bell and spigot will be wiped free from any dirt or other foreign matter. All surfaces of the portion of the pipe to be joined, and the factory-made jointing material, shall be clean and dry. Jointing material shall be used as recommended by the pipe or joint manufacturer’s specifications. The jointing material or factory-fabricated joints shall then be placed, fitted, and adjusted in such workmanlike manner as to obtain the degrees of water tightness required.

2. Trenches shall be kept as dry as possible during bedding, laying and jointing and for as long a period as required until the trench is backfilled. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line or grade.

3. All special fittings, such as wyes and other connections, shall be installed at the points indicated on the plans, in accordance with the standard detail drawings. Use appropriate adaptors to tie connection pipe to wyes. Plug end of connection with appropriate plug. See Standard Details 27.13, 27.14, 27.15, and 27.16. After the trench foundation has been properly graded to receive the pipe, the pipe shall be carefully lowered into the trench with approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be replaced at the Contractor’s expense.

4. At least 4 joints shall be left exposed for inspection purposes during the working day and a suitable ladder affording easy and safe access for such inspection shall be furnished.

5. Any defects due to settlement shall be made good by the Contractor at his own expense.

F. Temporary Suspension of Work:

When the trench is left for the night or if pipe laying is suspended, the upper end of the pipe shall be plugged to keep out dirt, water, animals and other foreign matter or substances. This plug shall be kept in the end of the pipe line at all times when laying is not in actual progress.

G. Cutting or Fitting Pipe:

Whenever a pipe requires cutting to bring a pipe to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools which will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe. The method of cutting pipe shall be in accordance with manufacturer's recommendations.

H. Ductile Iron Pipe

1. Bury limitations shall govern as follows based on the type laying condition:

Table 1		
Bury Limitations on DIP		
Pipe	**Maximum Bury to Invert of Pipe [a]**	
	Type 4 Laying Conditions – Equivalent to Class C Bedding (See Detail 27.01)	**Type 5 Laying Conditions – Equivalent to Class B Bedding (See Detail 27.01)**
8- inch DIP, Class 50	34 feet	50 feet
10- inch DIP, Class 50	28 feet	45 feet
12- inch DIP, Class 50	28 feet	44 feet
14- inch DIP, Class 50	27 feet	44 feet
16- inch DIP, Class 50	28 feet	44 feet

[a] Laying condition Type 4 is a 4-inch bed of stone with pipe embedded to 1/8 pipe diameter (equivalent to Class C bedding). Type 5 laying condition is also a 4-inch bed of stone with pipe embedded to the spring line of the pipe (equivalent to a Class B).

I. PVC PIPE

1. Installation shall comply with Underground Installation of Flexible Thermoplastic Sewer Pipe, ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*.

Table 2		
Bury Limitations on all PVC		
Pipe	**Bedding class**	**Maximum Bury to top of pipe**
SDR 26	Class B-1 w/ VDOT #57 stone	22 feet

2. Minimum cover shall not be less than 4 feet.

J. Reinforced Concrete Pipe

1. Pipe support for pipe shall provide uniform bearing for the pipe barrel along its entire length.
2. See Section 312000 Earth Moving for bedding requirements
3. Pipe with varying wall class must not be mixed between manholes or boxes.
4. Bury Limitations: Table 2 shall govern as the maximum allowable bury for concrete storm pipe:

Table 3				
Bury Limitations on RCP – 15 through 60 inches				
	Maximum Bury to Invert of Pipe [a]			
Pipe Class	**Class III (ft)**	**Class IV (ft)**	**Class V (ft)**	**Max Trench Width (ft)**
15- inch	9.5	14.5	23.0	4.0
18- inch	9.5	15.0	32.5	4.0
24- inch	11.5	23.0	50.0	4.0
30- inch	11.0	19.5	44.5	5.0
36- inch	10.5	18.0	35.0	6.0
42- inch	11.0	19.0	36.5	6.5
48- inch	11.5	19.5	37.5	7.0
54- inch	12.0	20.0	38.5	7.5
60- inch	12.0	20.5	38.5	8.0

[a] Based on saturated clay weighing 120 pcf, trench width as specified, class C stone bedding, 1350 plf per ft of internal diameter for class III and 2000 plf per ft of internal diameter for class IV, 3000 plf per ft of internal diameter for class V, D-0.01 crack

5. Join concrete pipe using bitumastic material to seal joint.
6. As each joint is laid, visually inspect to be certain that no jointing compound gasket or trash is protruding from the joint or lying inside the pipe.

3.3 MANHOLE

A. Standard Manholes: Manholes shall be constructed in accordance with Standard Details 27.02 and 27.03. Manholes shall be vacuum tested after installation of all mains and services

Manholes shall be installed plumb.

All lift holes shall be plugged with nonshrink grout.

B. Grade Rings/Adjustments:

The Contractor shall exercise care in the ordering of manholes so that the use of grade rings for leveling and adjustments can be minimized. In street rehabilitation work, the combination of grade rings shall not exceed 12 inches before removal of the cone is necessary to effect adjustment..

On all manholes, a mastic joint material shall be placed between the frame and cover and the cone or grade ring.

When applicable, during the installation of manholes, if frame and cover is near or within wheel path in roadway, turn cone to place the frame out of wheel path.

C. Drop Manhole

Invert elevations for drop connections in manhole shall be as shown on the plans.

Interior drop (Standard Detail 27.04) connections shall consist of either entirely schedule 40 PVC pipe with solvent cement joints or a combination of a Reliner inside drop bowl, or approved equal, and schedule 40 PVC pipe with solvent cement joints. Interior drop manholes shall be installed as shown in detail. The entire stack, including elbow, vertical section of pipe and tee with an outstanding open-end tee with plug, shall be strapped to the inside wall of the manhole with stainless steel bands lagged into wall of the manhole with stainless steel expansion bolts. A minimum of 2 steel bands shall be installed at a distance of no greater than 4 feet on center. Manholes shall be cored and booted for the inlet line.

Exterior drop connections (Standard Detail 27.05) shall consist of DIP and mechanical joint fittings. Exterior drop manhole shall be installed per detail. Manholes shall be cored and booted for the inlet line.

D. Flexible Pipe-to-Manhole Connector: The connector shall be installed per manufacturer's recommendations.

E. Installation of Manhole Frames and Covers: Frames and covers shall be installed to manhole with bolts in accordance with Standard Details 27.02 and 27.03. Butyl sealant shall be installed between the cone or adjusting ring and the frame and cover. Frame and covers shall be installed to elevation shown on plans. Adjustments shall be made as necessary to achieve design elevation.

3.4 ABANDONING SEWER LINES & MANHOLES

A. Sewer Lines: When an existing sewer line is designated to be abandoned in place, the low end of the line is to be plugged and lean concrete grout (flowable fill) pumped into the line until line is completely filled.

B. Manholes: When an existing manhole, either partially or wholly, is designated to be abandoned and the sewer lines, either entering or exiting the manhole, have been abandoned according to the preceding paragraph, the upper portion of the manhole shall be removed to a minimum of 18 inches below the proposed finished grade, or as determined by the City Construction Coordinator, VDOT #57 stone dumped into the manhole, and the stone vibrated to consolidate the stone. The remainder of the fill between the top of the manhole and the finished subgrade is to be backfilled as follows. Where the manhole is located within a roadway right of way, backfill with VDOT # 57 Stone and consolidate. Outside roadway right of ways, filter fabric shall be placed over the stone, suitable material of a compactable nature shall be placed over the top of the manhole, and the material tamped.

3.5 SERVICE CONNECTIONS

A. Sewer services shall be Schedule 40 PVC with solvent cement joints or DIP. Where laterals placed in non-buried conditions, the entire sewer service from main to property line shall be ductile iron pipe.

B. 4-inch and 6-inch sewer laterals shall be connected to the main by means of an in-line monolithic wye (see Standard Detail 27.14) or, if on an existing line with a tap and saddle installed over a hole cut in the top quadrant of the main at an angle of forty-five degrees, with respect to flow direction (see Standard Detail 27.16). The hole shall be cut with a mechanical circular type saw cutter designed for the particular use and rendering a smooth uniform cut with no damage to the main and is one which retrieves the plug. The cost for such cut-ins shall be included in the cost of the lateral.

C. A combination wye is to be provided at the cleanout set at the property line. All laterals are to be left exposed until the Construction Coordinators can verify the installation of each service.

D. Trench support, bedding, and backfill for laterals shall conform to the same specifications as those for sewer mains. All wyes, saddles, laterals, and cleanout assemblies shall be embedded in VDOT #57 stone. See Standard Details 27.14, 27.15, and 27.16 for bedding requirements of sewer laterals.

E. Vertical stacks or standpipe services are not allowed.

F. The cleanout shall be located at the right of way or easement line on the City side of the line and constructed as shown on Standard Detail 27.15

G. Minimum grade for services shall be 1/4-inch per foot.

H. Sewer lines shall be air tested (low-pressure air test) after the complete installation of all sewer services. Laterals shall be tested with the main line unless otherwise directed by the City Engineer.

3.6 TESTING

A. General Requirements

The following tests shall apply for the respective pipe materials and manholes as required by the following specifications.

Table 4

Table of Testing Applications

Material	**Air Test**	**Vacuum Test**	**Visual**	**Infiltration/Exfiltration**
RCP	X		X	
DIP	X		X	
PVC	X		X	
Manholes		X	X	
Pipe greater than 24 inches			X	X

Upon completion of entire pipe installation, the City Engineer may inspect the work in part or as a whole and make such tests as will satisfy himself/herself that every portion of the contract has been faithfully carried out.

If, in the opinion of the City Engineer or Project Engineer, a defect exists in the pipeline or its appurtenances, in some place not accessible except by uncovering, the City Engineer or Project Engineer may order the line to be uncovered.

Testing and inspection shall be completed within 90 days of installation and backfilling of sewer pipe including services. Testing intervals and sequences shall be as determined by the Construction Coordinator.

Furnish all pumps, gauges, instruments, test equipment, and personnel required for inspections and testing operations.

Flush all sand, dirt, and debris from lines prior to inspection. Provide lights and mirrors and inspect lines in presence of the Construction Coordinator.

Clean and pretest all pipe and manholes prior to notifying the Construction Coordinator and arranging for inspections and tests.

All final testing and inspections shall be performed in the presence of the Construction Coordinator. All final testing and retesting results shall be recorded on copies of test data sheets by the Construction Coordinator. Final tests and acceptance shall be based only upon a test after backfill is complete.

Inspect the system for conformance with line and grades shown on the plans and provide record drawings measurements on Record Drawings.

Visual Inspection: All sewer lines and manholes shall be visually inspected by the contractor/developer in the presence of the City Construction Coordinator from every manhole by use of mirrors and television cameras and in accordance with Section 330510 - Television Inspection of Sewer Lines. The lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines that do not exhibit a true and correct line and grade, have obstruction or structural defects, shall be corrected to meet these specifications and the sewer barrel left clean for its entire length.

B. Line Testing

1. Low-Pressure Air Tests

Low-pressure air test shall be the primary method of testing for pipe diameters 24 inches or less. Tests for PVC pipe shall comply with ASTM F1417. Tests for RCP pipe shall conform to ASTM C924. Tests for DIP shall conform to ASTM F1417 or appropriate ASTM DIP low-pressure air test for gravity sewers.

Before tests are made, all wyes, tees, or end of side stubs shall be plugged with flexible joint caps, or acceptable alternate, securely fastened to withstand the internal pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible-jointed lateral connection or extension.

Air leakage testing of installed system shall be performed with a continuous monitoring gauge no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of plus or minus 0.04 psi. All air used shall pass through a single, above ground control panel visible to the City of Lynchburg's Construction Coordinator.

Pressurize the system to 3.5 psi and measure the time interval for the pressure to drop 1.0 psi.

If the time, shown in Table I, Line Pressure Air Test Table (appendix) for ASTM F1417 tests and Table III, Minimum Test Time for Various Pipe Sizes (appendix) for ASTM C924 tests for the designated line size and length, elapses before the air pressure drops 1 psi, the section undergoing the test may be discontinued once the prescribed time has elapsed even though the 1.0 psi drop has not occurred. The section of line has passed. Record all readings.

If the pressure drops 1.0 psi before the appropriate time shown in Table I, Line Pressure Air Test Table (appendix) for ASTM F1417 tests and Table III, Minimum Test Time for Various Pipe Sizes (appendix) for ASTM C924 tests has elapsed, the air loss rate shall be considered excessive and that section of pipe has failed. Record all readings.

If any sections of pipe fail the air test, the Contractor shall determine, at their own expense, the source or sources of leakage and shall repair or replace all defective material and workmanship. The extent and type or repair that may be allowed shall be subject to the approval of the City Engineer. The repaired pipe installation shall be re-tested and required to meet the requirements of this test.

If the pipe to be tested crosses under a stream, the allowable pressure drop shall be 0 psi over the test period shown in Table 1 as tested from manhole to manhole.

Note: If the pipe to be tested is submerged in groundwater, the test pressure shall be increased 1.0 psi for every 2.31 feet the groundwater level is above the invert of the sewer. To determine groundwater level, the Contractor shall install a 4-inch PVC pipe on the outside of the manhole from the base of the manhole to above ground level. The bottom of this pipe shall be laid in a minimum of 18 inches of pipe bedding material to allow groundwater to enter the bottom of the pipe. Immediately prior to the line test, the groundwater elevation shall be determined by measuring down to the surface of the water in the PVC pipe from ground level. The PVC pipe shall be cut off below grade and capped or filled after an acceptable test has been obtained.

2. Infiltration/Exfiltration Test
   Infiltration/Exfiltration tests shall be used for pipe diameters greater than 24 inches.

   Allowable leakage of pipe using Infiltration/Exfiltration tests shall be limited to 100 gallons per day per inch diameter per mile or 2,400 gallons per day, whichever is less. If groundwater is 4 feet above top of pipe, use infiltration test. If groundwater is less than 4 feet above top of pipe, fill pipe and upstream manhole to produce a minimum 4-foot head over the top of pipe, let stand for 12 hours, refill manhole to original level, and conduct Exfiltration test for 1 hour.

C. Manhole Testing

Manholes shall be vacuum tested as indicated below unless otherwise allowed by the Engineer. Vacuum testing shall meet ASTM *C1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test*, or latest revision.

The test shall be made using an inflatable compression band, vacuum pump, and appurtenances specifically designed for vacuum testing manholes. Equipment to be manufactured by Peter A Glazier & Associates, Worchester, MA or approved equal.

Manholes may be tested by vacuum test immediately after assembly of the manhole, frames and connecting pipes and before any backfill is placed around the manholes. However, the final test and acceptance shall be based only upon a test after the manhole is backfilled and the cover frame castings are set to grade and grouted in place. Manholes shall be tested from the top of the casting, including the casting-to-cone joint (adjusting ring). Testing devices shall be installed on the metal manhole frame.

All pipes shall be plugged, taking care to securely brace the plugs and pipe. Stubouts, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.

Installation and operation of vacuum equipment and indicating devices shall be in accordance with manufacturer's recommendations.

After the testing equipment is in place, a measured vacuum of 10 inches of mercury (Hg) shall be established in the manhole. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury. The maximum allowable leakage rate for manholes shall be in accordance with Table II at the end of this section.

If the manhole fails the test, the Contractor shall locate the leakage, make the proper repairs, and the vacuum test shall be repeated until the manhole passes the test. After the manholes have been backfilled and the cover frame casting sealed in place, and prior to final acceptance of the project, any signs of leaks or weeping visible from the inside of the manhole shall be repaired and the manhole made watertight and tested. The extent and type of repairs that may be allowed shall be subject to the approval of the City Engineer. Leaks shall be repaired on the outside of the manhole unless approved otherwise by the City Engineer.

If a manhole joint mastic material is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

TABLE 1

Line Pressure Air Test Using Low-Pressure Air

SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP

FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

(Excerpted from ASTM F 1417)

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec.)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:40	5:42
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33

TABLE II VACUUM TEST TABLE FOR MANHOLES BASED ON ASTM C 1244					
MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS FOR PRESSURE DROP FROM 10 INCHES TO 9 INCH HG.					
Diameter, Inches					
Depth (ft)	48	54	60	66	72
Time, Seconds					
6	15				
8	20	23	26	29	33
10	25	29	33	36	41
12	30	35	39	43	49
14	35	41	46	51	57
16	40	46	52	58	67
18	45	52	59	65	73
20	50	53	65	72	81
22	55	64	72	79	89
24	59	64	78	87	97
26	64	75	85	94	105
28	69	81	91	101	113
30	74	87	98	108	121

TABLE III Line Pressure Air Test Using Low-Pressure Air SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP (Excerpted from ASTM C 924)	
1 Pipe Diameter (in.)	2 T (time), (min : 100 ft)
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0

END OF SECTION

SECTION 22 1316

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.

B. Related Sections:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.3 PERFORMANCE REQUIREMENTS

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

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

1.4 ACTION SUBMITTALS

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

B. Provide piping schedule indicating type of intended installation and installation location. Refer to piping schedule below.

C. Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, ductwork layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items involved: (Submit 3 hard copies of all documents to Architect for Review):

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Piping installation in congested spaces, indicating coordination with general construction, building components, and other building services.
3. Suspended ceiling components.
4. Structural members to which duct will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Penetrations of smoke barriers and fire-rated construction.
7. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

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

    a. Charlotte Pipe and Foundry.
    b. AB&I Foundry.
    c. Tyler Pipe.

2. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

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

   a. Charlotte Pipe and Foundry.
   b. AB&I Foundry.
   c. Tyler Pipe.

B. Heavy-Duty, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

A. DWV Copper Tubing:

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

   a. Mueller Industries.
   b. Cambridge-Lee Industries.
   c. Cerro Flow Products

2. Standards: ASTM B 306, Type DWV
3. Description: Drainage tube, drawn temper.

B. Copper Drainage Fittings:

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

   a. Mueller Industries.
   b. NIBCO.
   c. Elkhart Products Corporation
   d. Cello Products.

2. Standards: ASME B16.23 or ASME B16.29.

3. Description: Cast copper or wrought copper, solder-joint fittings.

C. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

4. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.
2) Dresser, Inc.
3) Smith-Blair, Inc.; a Sensus company.
4) The Ford Meter Box Company, Inc.
5) Viking Johnson.

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, provide products by one of 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: 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, provide products by one of 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: 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.
        4) Pipeline Seal and Insulator, Inc.

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, provide products by one of 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.

2.6 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.

PART 3 - EXECUTION

3.1 EARTH MOVING

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

3.2 PIPING INSTALLATION

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

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

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

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

P. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

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

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

T. Install escutcheons for piping penetrations of walls and ceilings.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. 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.

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.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure 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 unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 6: Use dielectric flange kits or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping.
3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. 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.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

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

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

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

1. NPS 1-1/2 and NPS 2: 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.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

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

G. 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.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect 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. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
5. 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. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

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

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

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

3.10 PIPING SCHEDULER

A. Aboveground, soil and waste piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

B. Aboveground, vent piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Copper DWV tube, copper drainage fittings, and soldered joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Underground, soil, waste, and vent piping shall be the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 1319

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Miscellaneous sanitary drainage piping specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Cleanouts
2. Floor drains

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

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

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

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

1) MIFAB, Inc.
2) Smith, Jay R. Mfg. Co.
3) Watts Drainage Products.
4) Zurn Plumbing Products Group.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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

a. MIFAB, Inc.
b. Smith, Jay R. Mfg. Co.
c. Watts Drainage Products.
d. Zurn Plumbing Products Group;

2. Refer to fixture schedule on drawings.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

B. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.5 FLASHING MATERIALS

A. 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.

B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. 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. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

E. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

F. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

G. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect wiring according to Section 260519 "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 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 counter-flashing or commercially made flashing fittings.

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 1323

SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Oil interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PP: Polypropylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of coalescing interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For oil interceptors to include in emergency, operation, and maintenance manuals

PART 2 - PRODUCTS

2.1 OIL INTERCEPTORS

A. Oil Interceptors: Coalescing Filter Style with precast concrete shell complying with ASTM C 913.

1. Manufacturers: Subject to compliance with requirements, provide basis of design product or approved equal.

2. Manufacture: Contech Engineered Solutions

3. Model: VortClarex VCL-60-1

4. Concrete for the precast VortClarex system shall conform to ASTM C 857 and C 858 and meet the following additional requirements:

5. The exterior wall thickness shall not be less than 6-inches (152 mm) or as shown on the dimensional drawings prepared by Contech Engineered Solutions LLC. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20 (MS18) loading requirements as determined by a Licensed Professional Engineer.

6. Sections shall have tongue-and-groove joints or shiplap joints and be sealed with a butyl mastic sealant designed to be resistant to fuel and oil such as ConSeal Brand CS-440 or approved equal. All joints will be above the resting water level.

7. Cement shall be Type II Portland cement, or approved equal, conforming to ASTM C 150.

8. All precast concrete sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or until 5 days after fabrication and/or repair, whichever is longer.

9. Coalescing media shall be manufactured by Facet International and be made of calcium carbonate filled polypropylene corrugated plates, with corrugation angles no less than 45° with respect to longitudinal axis of the plate corrugations. Plates shall be spaced at ½-inch (13 mm) intervals and be stacked and bound together with sturdy rods and supports to form modular plate packs.

10. Polyurethane elastomeric sealant shall comply with ASTM D-412 and GSA Specification TT-S-00230C, Type II, Class A and ASTM C-920, Type S, Grade NS.

11. Manhole frames and covers shall be provided by the manufacturer in the numbers and configurations as shown on the dimensional drawings prepared by Contech.

12. Hatchways shall be provided by the manufacturer in the numbers and configurations as shown on the dimensional drawings prepared by Contech. Hatchways shall be made of Cast Iron, steel or aluminum, and shall meet HS20-44 (MS18) loading requirements.

13. Brick or masonry used to build the casting and hatchway frames to grade shall conform to ASTM C 32 or ASTM C 139 and shall be installed in conformance with all local requirements.

B. Capacities and Characteristics:

1. Capacity: 225 gpm
2. Overall Dimensions: 13’x7’x7’deep.
3. Inlet and Outlet Pipe Size: 6 NPS
4. Vent Pipe Size: 3 NPS
5. Installation Position: Underground with manhole and access hatch riser to grade.

2.2 PRECAST-CONCRETE MANHOLE RISERS

A. Precast-Concrete Manhole Risers: ASTM C 478 (ASTM C 478M), with rubber-gasket joints.

1. Structural Design Loads:
   a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).

2. Length: From top of underground concrete structure to grade.
3. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
5. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
6. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12-inch intervals.

B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated grade elevation and slope. Provide traffic rated cover at grade.

C. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange and 26-inch diameter cover.

1. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
2. Include indented top design with lettering cast into cover, using wording equivalent to the following:
   a. Oil Interceptors in Sanitary Sewerage System: “OIL INTERCEPTOR”.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION

A. Install coalescing filter style precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Each VortClarex system shall be constructed according to the sizes shown on the drawings and as specified herein. Install at elevations and locations shown on the drawings or as otherwise directed by the engineer.

C. Place the precast base unit on a granular subbase of minimum thickness of 6 inches after compaction or of greater thickness and compaction if specified elsewhere. The granular subbase shall be checked for level prior to setting and the precast base section of the vault shall be checked for level at all four corners after it is set. If the slope from any corner to any other corner exceeds 0.5% the base section shall be removed and the granular subbase material re-leveled.

D. Prior to setting subsequent sections place ConSeal brand CS-440 butyl mastic sealant, or approved equal in conformance with ASTM C 990-91, along the construction joint in the section that is already in place.

E. After setting the precast roof section of the VortClarex system, set riser sections to the height required to bring the cast iron manhole covers or hatches to grade, so that the sections are vertical and in true alignment with a ¼-inch (6 mm) maximum tolerance allowed. Backfill in a careful manner, bringing the fill up in 6-inch (152 mm) lifts on all sides. If leaks appear, clean the inside joints and caulk with lead wool to the satisfaction of the Engineer. Precast sections shall be set in a manner that will result in a watertight joint. In all instances, installation of the VortClarex system shall conform to ASTM specification C 891 “Standard Practice for Installation of Underground Precast Utility Structures”.

F. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

G. Set tops of manhole frames and covers flush with finished surface in pavements.

H. Set interceptors level and plumb.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

C. Provide 3” vent connections on the inlet and outlet pipe. Extend vent riser to grade and terminate with a perforate vent cap.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION

SECTION 22 1513

GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig or less.

B. Related Sections include the following:

1. Section 115700 "Compressed Air Equipment" for general-service air compressors and accessories.

1.3 DEFINITIONS

A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 ACTION SUBMITTALS

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Valves
3. Flexible pipe connectors.
4. Safety valves.
5. Pressure regulators. Include rated capacities and operating characteristics.
6. Automatic drain valves.
7. Filters. Include rated capacities and operating characteristics.
8. Quick couplings.
9. Hose assemblies.

B. Provide piping schedule indicating type of intended installation and installation location. Refer to piping schedule below.

C. Shop/Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items and trades involved: (Submit 3 hard copies of all documents to Architect for Review and Approval):

1. Piping installation in all spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to piping layout.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides.
4. Detail location of anchors, alignment guides, and expansion joints and loops.
5. Piping layout indicating sizes, configuration, and service.
6. Elevation of top of pipes.
7. Pipe fittings.
8. Reinforcement and spacing.
9. Structural members to which piping will be attached.
10. Hose reels and connection detail to reels.
11. Piping arrangement and connections to equipment
12. Compressed air equipment including compressors and receivers.
13. Location for filters and regulators.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Qualification Data: For Installers.

C. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. ASME Compliance:
1. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black coated with ends threaded according to ASME B1.20.1.

1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

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

2.3 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hammond Valve.
   b. Milwaukee Valve Company.
   c. NIBCO 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: Brass.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.4 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.

2. Description:

   a. Standard: MSS SP-70, Type I.
   b. NPS 2-1/2 to NPS 12, 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

2.5 FLEXIBLE PIPE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Metraflex, Inc.
3. Proco Products, Inc.

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

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

2.6 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.

1. Type: Pilot operated.

C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

D. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

E. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock

2.7 QUICK COUPLINGS

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

1. Aeroquip Corporation; Eaton Corp.
2. Foster Manufacturing, Inc.
3. Milton Industries, Inc.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
2. Plug End: Flow-sensor-bleeder, check-valve type with barbed outlet for attaching hose.

D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.

3.2 VALVE APPLICATIONS

A. Pipe NPS 2 and smaller:
1. Brass Ball Valves: Threaded ends, two piece, full port, brass with brass trim

3.3 PIPING INSTALLATION

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

B. Install piping concealed from view and protected from physical contact by building occupants, 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 otherwise indicated.

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

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.

I. Flanged joints may be used instead of specified joint for any piping or tubing system.

J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

L. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

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

P. Install sleeves for piping penetrations of walls, ceilings, and floors.

Q. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.4 JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipe 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 unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.

E. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

F. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

A. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

B. Install shutoff valve at inlet to each automatic drain valve, filter, and pressure regulator.

C. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

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

B. NPS 2 and Smaller: Use dielectric unions.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install stainless steel flexible pipe connectors in discharge piping of each air compressor.

B. Install stainless steel flexible pipe connectors at connection to each hose reel.

3.8 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping as indicated on drawings.

D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install mechanical filters in compressed-air piping as indicated on drawings. Mount on wall at locations indicated.

F. Install quick couplings at piping terminals for hose connections.

G. Install hose assemblies at hose connections.

3.9 CONNECTIONS

A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.10 HANGER AND SUPPORT INSTALLATION

A. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

B. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

C. Base of Vertical Piping: MSS Type 52, spring hangers.

D. Support horizontal piping within 12 inches of each fitting and coupling.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 to NPS 1/2: 96 inches with 1/2-inch rod.
2. NPS 3/4 to NPS 1-1/4: 84 inches with 1/2-inch rod.
3. NPS 1-1/2: 12 feet with 1/2-inch rod.
4. NPS 2: 13 feet with 1/2-inch rod.

G. Install supports for vertical, Schedule 40, steel piping every 10 feet .

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties.

3.12 PAINTING

A. Comply with requirements in Section 099100 "Painting" for painting interior piping.

B. Paint exposed, interior metal piping with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive or Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex semigloss.
d. Color:
1) Compressed air: Green

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish

3.13 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 180 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect pressure regulators for proper operation.

C. Prepare test reports

END OF SECTION

SECTION 22 1519

COMPRESSED-AIR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following compressed-air equipment and related accessories:

1. Air compressors and receivers.
2. Compressed-air dryers.
3. Compressed-air filter assemblies.

B. Related Sections include the following:

1. Division 22 Section "General Service Compressed-Air Piping" for compressed-air piping, valves, and related specialties.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

1.4 QUALITY ASSURANCE

A. All components shall be factory tested and documented to operate as a complete system

B. Manufacturer's Representative: The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.
1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out and start up.
2. Training: Provide technical representative to train Owner's maintenance personnel in operation and maintenance of specified equipment

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. ASME Compliance: Fabricate and label receiver tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NFPA 70, "National Electrical Code

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following compressed-air equipment:

1. Air compressors, including receivers and intake filters.
2. Compressed-air dryers.
3. Compressed-air filter assemblies.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.
1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Shop/Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items and trades involved: (Submit 3 hard copies of all documents to Architect for Review and Approval):

1. Piping installation in all spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to piping layout.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides.
4. Detail location of anchors, alignment guides, and expansion joints and loops.
5. Piping layout indicating sizes, configuration, and service.
6. Elevation of top of pipes.
7. Pipe fittings.
8. Reinforcement and spacing.
9. Structural members to which piping will be attached.
10. Hose reels and connection detail to reels.
11. Piping arrangement and connections to equipment
12. Compressed air equipment including compressors and receivers.
13. Location for filters and regulators.

D. Product Certificates: Certificates of shop inspection and data report for receiver tanks as required by ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.6 INFORMATION SUBMITTALS

A. Factory tests and inspection reports prior to shipping.

B. Field test and start-up reports, indicating and interpreting test results relative to compliance with specified requirements, for information

C. Certificates: For certification required in "Quality Assurance" Article

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

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. Belts: One set(s) for each belt-driven unit
   2. Filters: one set for each unit containing a filter

1.9 WARRANTY

A. Warrant work specified herein for two years from substantial completion against defects in materials, function and workmanship.

B. Warranty shall include materials and labor necessary to correct defects.

C. Defects shall include, but not be limited to noisy, rough, or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish.

D. All parts shall be readily available locally in the United States.

E. Any units or parts which prove defective during the warranty period will be replaced with OEM parts and transportation prepaid

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid, dusty conditions.

B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Mark Number of this specification.

C. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.11 LABELING

A. Nameplate: Manufacturer shall securely attach in a prominent location on each major item of equipment a non-corrosive nameplate with stamped figures showing manufacturer's name, address, model number, serial number and pertinent utility or operating data.

B. Lifting capacity shall be painted with letters and numbers 3 inches high Minimum on both sides of lifting mast assembly.

C. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (U.L.), or other National Recognized Testing Laboratory (NRTL), in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant

1.12 COORDINATION

A. Coordinate size and location of concrete bases. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.

PART 2 - PRODUCTS

2.1 PACKAGED AIR COMPRESSORS AND RECEIVERS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1; rated for working pressure at least as high as highest discharge pressure of connected compressors; and bearing appropriate code symbols. Include safety valve, pressure gage, automatic drain, and pressure-reducing valve.

C. Rotary screw compressor.

1. Manufacturers

D. Basis-of-Design Product: Subject to compliance with requirements, provide equipment by Atlas Copco or comparable product by one of the following:

1. Atlas Copco.
2. CompAir, Ltd.
3. Ingersoll-Rand; Air Solutions Group.

E. Compressor(s): Freestanding, full featured oil-flooded, rotary helical-screw type with lubricated helical screws and lubricated gear box.
   a. Mounting: Freestanding.

b. Inlet air filter: high duct, two stage dry-type air cleaner, 99.9% efficient at 3 microns and above. Provide a pressure differential sensor.

c. Rotor shafts: precision ground to tolerances within 12 microns. Rotor housing to be made of high quality, cose grain cast iron.

d. Bearings: Tapered roller thrust bearings. Thrust bearing housing to be made of close grain cast iron.
   1) Provide high quality cylindrical roller bearings to carry radial loads on the inlet end of the rotors.

e. Compressor to be provided with coolant dams at the duplex tapered roller bearing locations to immediately lubricate bearings when compressor starts.

f. Shaft seal: triple lip fitted to the male rotor.

g. Main drive motor- low speed four pole matched to the requirements of the compressor.
   1) Motor frame- Standard NEMA 1, 4 pole EISA open drip proof motors.
   2) Motor beatings: Vacuum degassed ball bearings for the drive end and non-drive end, grease lubricated rated for 18,000 hour service before re-lubrication.
   3) Motor insulation: Class F capable of operating in conditions up to 104 degrees F.

h. Belt drive: Non-overloading, automatic belt tension control designed to eliminate bearing overload.
   1) Provide protective enclosure to contain complete drive system

i. Coolant system-
   1) Coolant filtration- high capacity 5-micron, replaceable spin-on element with pressure bypass.
   2) Coolant/lubrication temperature control: accomplished through use of a thermostatic control valve mounted downstream of the oil cooler to control the flow of coolant through the oil cooler.

j. Provide integral dryer and coolant/air separation: accomplished through use of a three stage separation system.
   1) Provide air-cooled aftercooler to further cool the compressed air.
   2) The separator tank is mounted horizontally and is close coupled to the air end forming one module.
   3) Provide a pressure relief valve on the tank to protect the separator vessel.
   4) Provide a drain at the bottom of the tank and a coolant filler point.
   5) Provide a coolant level indicator.
   6) Provide a combined minimum pressure/check valve regulator to regulate the air discharge from the separator.
   7) Provide compressor with required coolant, factory filled.

k. Cooling system:
   1) Provide integral mounted air-cooled heat exchanger to cool both the coolant and compressed air. Cooler to be of tube and fin design, constructed from aluminum and designed to operate in ambient temperatures from 35 degrees F up to 104 degrees F. The after cooler is to cool the compressed air prior to discharge from compressor package.

l. Provide a motor driven low speed centrifugal cooling fan mounted in an internal segregated cooling compartment and discharge from a single point at the top of the unit. Provide a filter panel to pre-filter the cooling air. The cooling fan to be capable of up to ½" water gauge static pressure.

m. Provide moisture separator and drain directly downstream of the after cooler.

n. Piping: Provide flexible SAE hoses and JIC fittings, rigid steel piping, Bundy weld tubing, flexible connectors and nylon tubing as required to provide vibration free operation. Provide SAE O ring fittings on all connection larger than 3/8".

o. Controls:
   1) Provide advanced microprocessor control module to provide starting, stopping, capacity and pressure control, together with operating and safety control for the package.
   2) Instrument panel to be mounted on the front of the compressor, directly above the starter. The control panel to include:
      a) Run/stop selector switch and reset button
      b) "lock off" emergency stop button
      c) Pressure gauge
      d) Running hour meter
      e) Signal light for: power on (green), auto reset (white), common alarm (red).
      f) Dryer on/off switch
      g) Dew point indicator
   3) Provide with online/offline auto start and stop. Online/offline to allow compressor to operate at 2 points. The first is 100% full flow and the second is no flow.
   4) Controls to provide unload operation for immediate compressor internal system blow-down to minimize power requirements.
   5) The system will automatically reload to 100% capacity when the system falls to the online pressure setting.
   6) Provide with automatic stop/start with run time to allow the compressor to run unloaded for a predetermined time. If there is not demand within that period the unit shuts down to standby and will automatically restart and reload in the system pressure falls to the online pressure settings.

p. Starter: Provide a integrally mounted full voltage starter in a NEMA 4 enclosure with a transformer to accommodate control voltage.
   1) Motor overload protection to be designed and sized to match the specific characteristic of the motor.

q. Temperature protection: Should the temperature exceed 228 degrees F at the air end discharge the controller will shut down the compressor and illuminate the fault indicator.

r. Baseplate: One piece folded or fabricated steel to support all of the components. Provide high grade powder coat finish. Baseplate to be provided with fork lift slots.

s. Enclosure: Designed to provide effective sound emission control and suppression.
   1) Front door to be hinged to the side and can lift off if required to provide easy access to all routine maintenance points as follows:
      a) Check and add coolant
      b) Check intake filter condition and change
      c) Check coolant filter and change
      d) Change separator cartridge
      e) Service intake valve
      f) Service load solenoid valve
      g) Service blow down solenoid valve
      h) Drain and refill coolant
      i) Set and adjust load and unload operating pressures.
   2) Starter to be accessed through a single front mount door.

t. Provide with power out reset to safely return the compressor to the original operating condition following the interruption of power supply.

u. Provide with separate vertical remote receiver with external coating. Provide with drain valve kit.

v. Compressor to be provided with the following components:

1) Pre-filter
2) Automatic drain valve
3) Condensate drain
4) Moisture separator drain
5) Dryer drain
6) Air filter drain

F. Miscellaneous Devices: Provide safety valves, discharge-air pressure gages, pressure regulators, and shutoff valves.

2.2 ACCESSORIES

A. General: Include accessories with working-pressure rating not less than system pressure at location where used, and compatible with equipment and piping system used.

2.3 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Automatic Drain Valves: Electrical- or mechanical operation type with corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

C. Pressure Regulators: Bronze body, direct acting, spring loaded, manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases for compressed-air equipment. concrete materials and installation requirements are specified in Division 3.

3.2 EQUIPMENT INSTALLATION

A. Install air compressors on concrete bases. Install units level, plumb, and anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.

1. Anchor packaged equipment to concrete base.

    a. Install epoxy-coated anchor bolts for supported equipment; extend through concrete base and anchor into structural concrete floor.
    b. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Maintain manufacturer's recommended clearances for service and maintenance.

C. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
3. Automatic Drain Valves: Install on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.
4. Install shut-off valves and pressure gauges on compressor discharge and receiver discharge.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 11 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect piping to air compressors and receivers, except safety relief valve connections, with flexible pipe connectors of materials suitable for service.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. 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 and UL 486B.

3.4 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for compressed-air equipment.

3.5 TESTING

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to start-up inspect, test, and adjust components, assemblies, and equipment installations, including connections, check operation of the equipment and components for operation and performance as specified and examine the finish for damage. Provide report in writing that the installation meets the requirements and shall include information concerning minor adjustments and minor repairs, which may be required before final acceptance by the Owner.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Perform the following final checks:

   1. Verify that specified tests of piping systems are complete.
   2. Check for piping connection leaks.
   3. Check for lubricating oil in lubricated-type equipment.
   4. Check belt drives for proper tension.
   5. Verify that air-compressor inlet filters and piping are clear.
   6. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   7. Check safety valves for correct settings. Ensure that settings are greater than air-compressor discharge pressure but not greater than rating of system components.
   8. Test operation of equipment safety controls and devices.
   9. Drain receiver tanks.

D. Verify that compressed-air equipment is installed and connected according to the Contract Documents.

E. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

I. Prepare written report documenting testing procedures and results.

3.6 DEMONSTRATION

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

END OF SECTION

SECTION 22 1613

FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

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

B. Provide piping schedule indicating type of intended installation and installation location. Refer to piping schedule below.

C. Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, ductwork layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items involved: (Submit 3 hard copies of all documents to Architect for Review):

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Piping installation in congested spaces, indicating coordination with general construction, building components, and other building services.
3. Suspended ceiling components.
4. Structural members to which duct will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Penetrations of smoke barriers and fire-rated construction.
7. Items penetrating finished ceiling including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

D. Welding certificates.

E. Field quality-control reports.

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

1.6 QUALITY ASSURANCE

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

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

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

1.7 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.

1.8 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.

1.9 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

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

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

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. 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: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

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

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.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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 bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
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.

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.

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: 5 psig.

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

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. Eaton Corporation; Controls Div.
b. Harper Wyman Co.
c. Maxitrol Company.
d. SCP, Inc.

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

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.

c. Hart Industries International, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
f. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. 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. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
d. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange 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. Minimum Operating-Pressure Rating: 150 psig.
3. Companion-flange assembly for field assembly.
4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
5. Insulating materials suitable for natural gas.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective

jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to Fuel Gas Code of New York State to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with Fuel Gas Code of New York State requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

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

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

C. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 22 Section "Meters and Gages ".

3.4 INDOOR PIPING INSTALLATION

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

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

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

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

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

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

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

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

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

b. Do not install natural-gas piping in solid walls or partitions.

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

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

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

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

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

V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 22 Section "Meters and Gages."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section " Common Work Results for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section " Common Work Results for Plumbing 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 underground valves with valve boxes.

C. 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.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section "Mechanical Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semigloss).
d. Color: To match existing facility color scheme at location of installation.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).
d. Color: To match existing facility color scheme at location of installation .

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test gas piping at 15psi for one hour per SED requirements. Inspect, and purge natural gas piping according to the Fuel Gas Code of New York State.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 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.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.14 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 one of 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.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. Cast-Iron, lubricated plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:

1. Cast-Iron, lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION

SECTION 22 3400

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, High Efficiency power-vent, gas-fired, 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. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of gas-fired, domestic-water heater, from manufacturer.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

F. Shop/Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items and trades involved: (Submit 3 hard copies of all documents to Architect for Review and Approval):

1. Piping installation in all spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to piping layout.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides.
4. Detail location of anchors, alignment guides, and expansion joints and loops.
5. Piping layout indicating sizes, configuration, and service.
6. Elevation of top of pipes.
7. Pipe fittings.
8. Reinforcement and spacing.
9. Structural members to which piping will be attached.
10. Hose reels and connection detail to reels.
11. Piping arrangement and connections to equipment
12. Compressed air equipment including compressors and receivers.
13. Location for filters and regulators.

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. 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."

D. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater compression tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.7 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. Faulty operation of controls.
b. 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) Heat Exchanger: Five years.
2) Controls and Other Components: Three years.
3) Storage Tank: Five years.

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-Fired, STORAGE, domestic-WATER HEATERS

A. Commercial, High Efficiency, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following]:

a. American Water Heaters.
b. Bradford White Corporation.
c. Lochinvar Corporation.
d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
e. State Industries.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Storage-Tank Construction: Non-ASME-code steel with 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

4. 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: For use with power-vent, gas-fired, domestic-water heaters and natural-gas fuel.
g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
h. Temperature Control: Adjustable thermostat.
i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
j. 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.

5. Special Requirements: NSF 5 construction.
6. Power-Vent System: Exhaust fan, interlocked with burner.

2.2 Domestic-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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

a. AMTROL Inc.
b. Flexcon Industries.
c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
d. State Industries.
e. Watts

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. Refer to schedule on drawing.
b. Air Precharge Pressure: Adjust pre-charge in the field to equal incoming domestic cold water pressure.

B. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

C. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

D. 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.

E. 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.

F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

G. 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 specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters 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 Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 Domestic-WATER HEATER INSTALLATION

A. 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 Section 220523 "General-Duty Valves for Plumbing Piping."

B. 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 Section 231123 Facility Natural-Gas Piping.

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

E. Install thermometer on outlet piping of domestic-water heaters.

F. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 Facility Natural-Gas Piping.

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

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "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 Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "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 gas-fired, domestic-water heater.

END OF SECTION

SECTION 22 4000

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories, showers, and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Water closets.
7. Urinals.
8. Lavatories.
9. Commercial sinks.
10. Kitchen sinks.
11. Service basins.
12. Showers.

B. Related Sections include the following:

1. Division 10 Section 102800 "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section 221119 "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 224700 Section "Drinking Fountains."

1.3 DEFINITIONS

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

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

C. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

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

1.4 SUBMITTALS

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

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

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

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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

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

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

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

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

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
2. Stainless-Steel Residential Sinks: ASME A112.19.3.
3. Vitreous-China Fixtures: ASME A112.19.2M.
4. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
2. Faucets: ASME A112.18.1.
3. Hose-Connection Vacuum Breakers: ASSE 1011.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
6. NSF Potable-Water Materials: NSF 61.
7. Pipe Threads: ASME B1.20.1.
8. Supply Fittings: ASME A112.18.1.
9. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for shower faucets:

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

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.

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

1. Flexible Water Connectors: ASME A112.18.6.
2. Floor Drains: ASME A112.6.3.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets:

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

   a. Bradley Corporation.
   b. Chicago Faucets.
   c. Delta Faucet Company.
   d. T & S Brass and Bronze Works, Inc.

2. Description: Two-handle mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. See schedule on drawing.

2.2 SHOWER FAUCETS

A. Shower Faucets:

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

   a. Bradley Corporation
   b. Chicago Faucets.
   c. Moen
   d. Symmons Industries, Inc.
   e. T & S Brass and Bronze Works, Inc.

2. Description: Metering push-button thermostatic and pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

   a. See schedule on drawing.

2.3 SINK FAUCETS

A. Sink Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Chicago Faucets.
   b. Delta Faucet Company.
   c. Elkay Manufacturing Co.
   d. T & S Brass and Bronze Works, Inc.
   e. Symmons Industries, Inc.

2. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. See schedule on drawing.

2.4 FLUSHOMETERS

A. Flushometers:

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

   a. Delta Faucet Company.
   b. Sloan Valve Company.
   c. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

   a. See schedule on drawing.

2.5 TOILET SEATS

A. Toilet Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

   a. Bemis Manufacturing Company.
   b. Church Seats.
   c. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.

   a. Material: Molded, solid plastic.
   b. Configuration: Open front without cover.
   c. Size: Elongated.
   d. Hinge Type: CK, check.
   e. Class: Standard commercial.
   f. Color: White.

2.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

   a. Plumberex Specialty Products Inc.
   b. TCI Products.
   c. TRUEBRO, Inc.

d. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.7 FIXTURE SUPPORTS

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

1. MIFAB Manufacturing Inc.
2. Smith, Jay R. Mfg. Co.
3. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
4. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:

1. Description: Combination carrier designed for accessible or standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Lavatory Supports:

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

2.8 WATER CLOSETS

A. Water Closets:

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

a. American Standard Companies, Inc.
b. Eljer.
c. Kohler Co.
d. Sloan Valve Company.

2. See schedule on drawing.

2.9 LAVATORIES

A. Lavatories:

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

a. American Standard Companies, Inc.
b. Eljer.
c. Kohler Co.

2. See schedule on drawing.

2.10 KITCHEN SINKS

A. Kitchen Sinks:

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

   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.
   c. Kohler Co.

2. See schedule on drawing.

2.11 SERVICE BASINS

A. Service Basins:

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

   a. Crane Plumbing, L.L.C./Fiat Products.
   b. Florestone Products Co., Inc.
   c. Stern-Williams Co., Inc.
   d. Mustee, E. L. & Sons, Inc.

2. See schedule on drawing.

2.12 SHOWERS

A. Showers: Standard acrylic base and faucet.

1. PMMA (Acrylic) Showers:

   a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      1) Aqua Bath Company, Inc.
      2) Aqua Glass Corporation.
      3) Clarion Bathware.
      4) Crane Plumbing, L.L.C.
      5) Kohler Co.
      6) Willoughby Industries

2. See schedule on drawing.

2.13 SHOWER 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. Shower Faucets: Single handle, pressure balance, mixing valve.

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

1) American Standard America.
2) Kohler Co.
3) Moen Incorporated.
4) Powers.
5) Symmons Industries, Inc.

2. See schedule on drawing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

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

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

3.2 INSTALLATION

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

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

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

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

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

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

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

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

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

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

K. Install toilet seats on water closets.

L. Install traps on fixture outlets.

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

M. Install chrome plated escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

N. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

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

P. Install shower flow-control fittings with specified maximum flow rates in shower arms.

Q. Set shower receptors in leveling bed of cement grout.

3.3 CONNECTIONS

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

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

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

3.4 FIELD QUALITY CONTROL

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

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

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

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

3.5 ADJUSTING

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

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

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

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

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

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

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

END OF SECTION

SECTION 22 4716

PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pressure water coolers and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 3 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLER/BOTTLE FILLING STATION

A. Pressure Water Coolers Flush to wall, wheelchair 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. Elkay Manufacturing Co.
    b. Halsey Taylor.
    c. Oasis

2. Standards:

    a. Comply with NSF 61.
    b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

3. Cabinet: All stainless steel.
4. Bottle filling station: 1.1 to 1.5gpm
5. Bubbler: One, with adjustable stream regulator, located on deck.
6. Water Cooler Control: Push button.
7. Bottle Fill Control: Electronic sensor with automatic shutoff timer.
8. Drain: Grid with NPS 1-1/2 (DN 32) tailpiece.
9. Supply: NPS 3/8 (DN 10) with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/2 (DN 32) brass P-trap.
11. Filter: Water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards, with capacity sized for unit peak flow rate.
12. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

    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.

13. Capacities and Characteristics:

    a. Cooled Water: 8 gph.
    b. Ambient-Air Temperature: 90 deg F.
    c. Inlet-Water Temperature: 80 deg F.
    d. Cooled-Water Temperature: 50 deg F.
    e. Electrical Characteristics:

        1) Motor Horsepower: 1/5.
        2) Volts: 120-V ac.
        3) Phase: Single.
        4) Hertz: 60.
        5) Full Load Amps: 6

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 mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.

D. 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 Section 220523 "General-Duty Valves for Plumbing Piping."

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

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

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

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing fixture, 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

DIVISION 23
HEATING VENTILATING AND AIR CONDITIONING

SECTION 23 0500

MOTORS AND VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in the Contract Documents.

1.3 SUBMITTALS

A. Submit manufacturer's product data on all motors and variable frequency drives. Provide voltage, rpm, enclosure type, frame type, and rated efficiency and duty.

PART 2 - PRODUCTS

2.1 MOTORS

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

1. Baldor (Basis of design)

B. General Requirements:

1. Motors built for 60 Hz operation, three phase for 1/2 hp and larger; single phase for 1/3 hp and smaller. In compliance with NEMA Standards, wound specifically for nameplate voltage and selected for appropriate duty and environment. 1.15 minimum service factor at rated voltage and frequency. Bearings rated 20,000 life hours. V-belt connected motors with adjustable slide rail bases and pulleys. Motors shall have Class F insulation system with Class B temperature rise. Maximum allowable motor temperature rise for open drip-proof or totally enclosed fan cooled (TEFC) type at 1.15 service factor shall be 80°C above 40°C ambient up to 300 hp. NEMA locked rotor kVA code as required to match unit equipment torque characteristics. Single-phase motors shall be capacitor start, induction run or split phase type. Polyphase motors shall be constant speed, squirrel cage, unless otherwise called for. Nameplates shall have as a minimum all information as described in NEMA Standard MG-1-20.60.

2. Motors for use with variable speed drive applications shall be inverter duty rated in accordance with NEMA. These motors shall meet NEMA corona inception voltage requirements, withstanding peak voltages up to 1600 volts and be manufactured in accordance with NEMA MG-1 Part 31. Shaft grounding brushes required on all motors for use with variable speed drives.
3. Three phase motors rated 1 hp and greater shall be special design, copper winding, relubable ball bearings, 1.15 service factor, premium efficiency, energy-saver type with a guaranteed NEMA nominal full-load efficiency, by IEEE Standard 112 Test Method "B". Motors to have three (3) year warranty. Efficiency rating shall appear on nameplate and shall be not less than as follows:

MINIMUM NOMINAL FULL-LOAD MOTOR EFFICIENCY						
HP	**OPEN MOTORS (RPM)**			**CLOSED MOTORS (RPM)**		
	1200	**1800**	**3600**	**1200**	**1800**	**3600**
1.0	82.5	85.5	77	82.5	85.5	77.0
1.5	86.5	86.5	84	87.5	86.5	84
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7

4. Nominal Motor Voltage Table:

Nominal System Voltage	Motor Nameplate
480V - 3 phase	460 volt
240V - 1 phase and 3 phase	230 volt
208V - 1 phase and 3 phase	200 volt
120V - 1 phase	115 volt

5. Motor Application: Provide the following enclosure types unless noted:

Environment/Location	Motor Enclosure Type
General Purpose	Open drip-proof with cast iron frame, TEFC with cast iron frame, or encapsulated
Outdoors, below grade or high humidity	TEFC with cast iron frame
Hazardous	Explosion-proof
Packaged Refrigeration Compressors	Hermetic or semi-hermetic

6. Manufacturers: Need not be all of same make, but one (1) of the following: General Electric GE, Gould, Baldor Super E, Emerson E-Line (US Motors), A.O. Smith Century E-Plus, Lincoln Ultimate E CTAC, Marathon XR1, Siemens GP100A.

C. Variable Frequency Drives (VFD's):

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

   a. Square D; a brand of Schneider Electric (Basis of design is E-Flex)
   b. ABB
   c. Eaton Electrical Inc: Cutler Hammer business unit

2. Warranty

   a. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

      1) Parts: Period of one year from substantial completion, to be free from defects in material and workmanship. Any units or parts which prove defective during the warranty period will be replaced with OEM parts and transportation prepaid.

   b. For Labor: One year(s) from date of Substantial Completion

3. General Description

   a. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
   b. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage.
   c. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
   d. The adjustable frequency NEMA 1 drive package shall consist of a circuit breaker disconnect, line reactor, EMI/RFI filter (if drive design requires RFI interference protection), 120V control transformer, control circuit terminal board for digital and analog field wiring. AC line fuses do not meet specification.
   e. The drive door shall have mounted and wired, Hand-Off-Auto switch, Manual Speed Potentiometer and AFC-Off- switch.
   f. The entire drive package, shall be UL508C listed and coordinated with NEMA ICS 7.1. A UL508A panel builders label does not meet specification.
   g. The drive shall include a damper solenoid end switch. Switch closure to be made prior to fan being energized.
   h. Provide with preset speed input to accommodate high speed operation from auxiliary 24 V signal.

4. Construction

   a. The AC Drive power converter shall be enclosed in a NEMA Type 1 enclosure with a circuit breaker disconnect, user terminal strip connections . The enclosure shall provide dedicated user terminals for power and control device connection.

b. Provisions shall be included for locking the disconnect in the OFF position with a padlock.
c. All enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.
d. Enclosure shall be slimline version.

5. Application Data

a. The AC Drive shall be sized to operate a variable torque load.
b. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

6. Environmental Ratings:

a. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and CSA standards.
b. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 ˚C (14 to 104 ˚F).
c. AC Drives in Type 1 enclosures shall be designed to operate in an ambient temperature from -10 to 50 ˚C (14 to 122 ˚F) and in full sunlight.
d. The storage temperature range shall be -25 to 65 ˚C (-13 to 149 ˚F).
e. The maximum relative humidity shall be 95%, non-condensing.
f. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive should be de-rated per drive specifications.
g. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.
h. The AC Drive shall be Seismic Qualified to 2000 IBC Level 3 “Extreme” rating with an Importance Factor 1p=1.5

7. Ratings:

a. The AC Drive shall be designed to operate at the input line voltage indicated on the equipment schedule.
b. The AC Drive shall operate from an input frequency range of 60 Hz (±) 5%.
c. The displacement power factor shall not be less than .98 lagging under any speed or load condition.
d. The efficiency of the AC Drive at 100% speed and load shall not be less than 97%.
e. The variable torque rated AC Drive over current capacity shall be not less than 110% for 1 minute.
f. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4 or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

8. Protection:

a. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.
b. The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate. Short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
c. The AC Drive shall be protected against short circuits, between output phases and to ground.
d. The AC Drive shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles).
e. The AC drive shall have a programmable ride-through function, which will allow the logic to maintain control for a minimum of one-second (60 cycles) without faulting.
f. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 6 programmable restart attempts. The time delay before restart attempts will be 30 seconds.
g. Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.
h. The AC Drive shall have a solid-state UL 508C listed overload protective device and meet IEC 60947.
i. The output frequency shall be software enabled to fold back when the motor is overloaded.
j. There shall be three skip frequency ranges that can be programmed to a bandwidth of ± 2.5 Hz.

9. Adjustments and Configurations:

a. The AC Drive will be factory programmed to operate all specified optional devices.
b. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.
c. The memory shall retain and record run status and fault type of the past eight faults.
d. The software shall have an energy economy function that, when selected, will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load. Selectable volts/Hz ratio patterns does not meet specification, the function must be automatically optimized.

10. Keypad Display Interface:

a. A keypad display interface shall offer the modification of AC Drive adjustments through a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible.

b. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.

c. The keypad display shall have a hardware selector switch that allows the keypad to be locked out from unauthorized personnel.

11. Operator Controls:

a. The control power for the digital inputs and outputs shall be 24 Vdc.

b. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.

c. Pull-apart terminal strips shall be used on all logic and analog signal connections in the power converter

d. Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status.

e. The combination enclosure shall have the following dedicated operator controls:

1. Hand-Off-Auto switch
2. Manual Speed Potentiometer
3. AFC-Off- switch

f. The combination enclosure shall include terminal point connection for fire /freeze state interlock, to prevent drive operation. The interlock must shut down the motor in the drive modes.

12. Serial Communication

a. DDC interface card with the following features:

1. The AC Drive shall have serial communications capability.
2. Interface with DDC system.
3. Capability to drive optional remote digital display of volts, amps, frequency and instantaneous electronic trip (I.E.T.) indication.
4. Analog volts, amps, frequency signals to drive analog meters.
5. Two (2) sets of auxiliary totally selectable field programmable contacts
6. Spare Form 'C' run relay contact available for Owner's use.

13. Harmonic Mitigation

a. Each drive shall include a line reactor mounted inside the drive enclosure to reduce power system harmonics and provide power quality protection for the drive. DC bus chokes do not meet specification and shall not be substituted.

PART 3 - EXECUTION

3.1 MOTORS

A. Furnished by equipment manufacturer and especially manufactured and/or selected, mounted, and installed for intended use. Install motors accessible for maintenance and belt adjustment.

3.2 VARIABLE FREQUENCY DRIVES

A. Set in place controllers on 4 in. high concrete base or on wall or freestanding steel frame as required. Completely erect and assemble, including shipping splits, and make respective connections from terminal or terminal strips to any miscellaneous control devices.

B. Provide respective line side power supply connections to load side power terminals. Adjust unit controls in accordance with manufacturer's instructions.

C. Adjust unit controls in accordance with manufacturer's instructions.

D. A factory-trained manufacturer's service representative shall provide complete start-up services at the site during construction plus a separate (after startup on a 100% correctly operating drive) four (4) hour training session for the Owner.

E. Equipment manufacturer to provide a one (1) year full parts and labor warranty from date of start-up and Owner acceptance.

END OF SECTION

SECTION 23 0517

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. 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 (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

2.2 GROUT

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

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

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

B. 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.

C. 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 (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

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

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6 Galvanized-steel wall sleeves

2. Interior Partitions:

a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves

END OF SECTION

SECTION 23 0518

ESCUTCHEONS FOR HVAC 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.

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.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass finish.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 23 0519

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gauges.
4. Gauge attachments.
5. Test plugs.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-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 Air-Duct Installation: With ventilated shroud.
    b. 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.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

A. Thermowells:

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

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

2.4 PRESSURE GAUGES

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.

9. Window: Glass.
10. Ring: Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAUGE ATTACHMENTS

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

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

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

2.6 TEST PLUGS

A. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
3. Thread Size: NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F
5. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Provide thermowells associated with each thermometer. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

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

F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

H. Install valve and snubber in piping for each pressure gauge for fluids.

I. Install test plugs in piping tees.

J. Install siphons where required to protect from high temperature damage of gauges.

K. Install permanent indicators on walls or brackets in accessible and readable positions.

L. Install connection fittings in accessible locations for attachment to portable indicators.

M. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler
3. Inlet and outlet of each hydronic pump
4. Inlet and outlet of each hydronic coil.
5. Outside-, return-, supply-, and exhaust-air ducts.
6. As shown on drawings

N. Install pressure gauges in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler
3. Inlet and outlet of each hydronic pump
4. Inlet and outlet of each hydronic coil
5. As shown on drawings

3.2 CONNECTIONS

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

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers as listed above and as shown on drawings shall be the following:

1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.
3. Install thermometers in thermowells.

B. Thermometers at outside-, return-, supply-, and exhaust-air ducts shall be the following:

1. Industrial-style, liquid-in-glass type.

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

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 200 deg F.

B. Scale Range for Air Ducts: Minus 40 to plus 110 deg F.

3.6 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges listed above and as shown on drawings shall be the following:

1. Sealed, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.
3. Install pressure gauge in snubber

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi

END OF SECTION

SECTION 23 0523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze gate valves.
3. Iron gate valves.
4. Bronze swing check valves
5. Iron swing check valves
6. Iron, grooved-end swing-check valves.
7. Chainwheels

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.
2. Division 23 Section "HVAC hydronic piping."
3. Division 23 Section "HVAC hydronic piping specialties."

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.

B. Provide valve schedule indicating intended type of valve to be installed and installation location. Refer to valve schedule below.

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.

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.

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 HVAC 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.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article

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.

F. Valve-End Connections:

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

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   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: Soldered.
   g. Seats: PTFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.3 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.

b. NIBCO INC.
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: Soldered.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron

2.4 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, 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.

2.5 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. American Valve, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig

c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze

2.6 IRON SWING CHECK VALVES

A. Class 150, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 126, gray iron with bolted bonnet.
   f. Ends: Flanged.
   g. Trim: Bronze.
   h. Gasket: Asbestos free.

2.7 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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

2.8 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

C. Examine 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 from floor level and provide separate support where necessary. Provide piping and fittings as required to located valves in an easily accessible area. Contractor shall coordinate valve location to maintain proper access and maintenance with all other building systems. (i.e. ductwork, equipment, structure, walls, etc.).

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 chain operated valve for any valve required to be installed 6 feet above finished floor or higher if it is below the ceiling or structure above.

F. Install check valves for proper direction of flow and as follows:

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

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 or gate valves.

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.

3.5 HOT-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze Ball Valves: Solder-joint, two piece, full port, bronze with bronze trim.
2. Bronze Swing Check Valves: Solder-joint, bronze disc

B. Pipe NPS 2-1/2 and Larger:
1. Iron Gate Valves: Flanged pipe fitting installation, Class 125 NRS.
2. Iron swing check valves: Flanged or grooved fitting installation.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:
1. Division 23 Section "Metal Ducts" for duct hangers and 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 signed and sealed by a qualified professional engineer, licensed in Virginia, responsible for their preparation. Design to include hangers associated with supports from walls, columns, or the structure above using performance requirements and design criteria indicated. All building attachments to be coordinated with building manufacture.

1. Detail fabrication and assembly of hangers.
2. Design Calculations: Calculate requirements for designing hangers

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: 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. Pipe stands.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: Refer to above

B. 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: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel

C. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   b. Standard: MFMA-4.
   c. Channels: Continuous slotted steel channel with inturned lips.
   d. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   e. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
   f. Metallic Coating: Hot-dipped galvanized.
   g. Paint Coating: Vinyl, Epoxy or Alkyd
   h. Plastic Coating: Polyurethane or Epoxy

B. Non-MFMA Manufacturer Metal Framing Systems
1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   b. Standard: Comply with MFMA-4.
   c. Channels: Continuous slotted steel channel with inturned lips.
   d. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   e. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel

2.4 THERMAL-HANGER SHIELD INSERTS

A. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:

B. Insulation-Insert Material for Cold and heat pump 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: 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.

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. Mechanical-Expansion Anchors: Insert-wedge-type, 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.

B. Coordinate building attachments with pre engineered metal building manufacturer.

2.6 EQUIPMENT SUPPORTS

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

B. Coordinate building attachments with pre engineered metal building manufacturer.

2.7 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 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 mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

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

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.

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

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

L. Insulated Piping:

1. Attach clamps and spacers to piping.

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

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

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

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

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

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

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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 or metal trapeze pipe hangers and attachments for general service applications.

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

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

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

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

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 8, requiring clamp flexibility and up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 8 if little or no insulation is required.
4. 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.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 8.
12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
13. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 8, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 8, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
15. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 8 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
16. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 8, from two rods if longitudinal movement caused by expansion and contraction might occur.
17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 8, from single rod if horizontal movement caused by expansion and contraction might occur.
18. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 8 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
19. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 8 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
20. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 8 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 8.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 8 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: Coordinate building attachments with pre-engineered metal building manufacturer. 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.
16.

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

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 SUBMITTALS

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

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

C. Valve numbering scheme.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. 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 6 by 2 inch.
3. Minimum Letter Size: 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.

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

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

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

E. 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: Yellow.

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

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

F. Minimum Letter Size: 1/2 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. 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. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. 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 DUCT LABELS

A. Install plastic-laminated duct labels with permanent adhesive on air ducts.

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

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

D. 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.

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

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

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

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 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. 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.

B. Pipe Label Color Schedule:

1. Heating Water Piping:

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

2. Condensate Piping
   a. Background color: Yellow
   b. Letter Color: Black

3. Refrigerant Piping:

   a. Background Color: Blue.
   b. Letter Color: White

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Supply Ducts:

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

2. Return Ducts:

   a. Background Color: Red.
   b. Letter Color: White.

3. Outside-Air Ducts:

   a. Background Color: Blue.
   b. Letter Color: White.

4. Exhaust Ducts:

   a. Background Color: Green.
   b. Letter Color: White.

5. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Hot Water: 1-1/2 inches, round.
   b. Refrigerant: 1-1/2 inches, round.

2. Valve-Tag Color:
   a. Hot Water: Natural Brass.
   b. Refrigerant: Natural Brass

3. Letter Color:

   a. Hot Water: Black.
   b. Refrigerant: Black

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

b. Variable-air volume systems

2. Balancing Hydronic Piping Systems:

a. Variable-flow hydronic systems.

1.3 RELATED SECTIONS

A. Section 230993- " Sequence of Operations for HVAC controls"

1.4 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

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

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB reports.

C. Sample report forms.

1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity currently and for the duration of the project, certified by NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and currently certified by NEBB.
2. TAB Technician: Employee of the TAB contractor and individual who is currently certified by NEBB as a TAB technician.
3. TAB contractor shall maintain NEBB certification for the duration of the project.

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

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.

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

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

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

1.8 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

C. Perform TAB on equipment after a factory authorized service representative has completed the start up service and written report is approved by architect.

PART 2 - PRODUCTS - *Not Used*

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

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

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

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

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

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

I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

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

K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

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

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

N. Examine system and coordinate with other disciplines to ensure all air has been bleed.

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

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation,"

Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

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

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

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

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

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

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

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

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

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

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

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices such as heat recovery equipment and air filters under final balance conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

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

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts. Provide sheaves and belts as required to achieve indicated airflows.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts

B. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank
3. Check flow-control valves for specified sequence of operation, and set at indicated flow.
4. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

5. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, proceed as specified above for hydronic systems.

B. Measure operating static pressure at the differential pressure sensor that controls the pumps and verify correct operation.

C. Balance systems with automatic two- and three-way control valves by setting systems at minimum and maximum flow through terminals, proceed as specified above for hydronic systems

D. Measure operating static pressure at the differential pressure sensor that controls the pumps and verify that it is being maintained.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

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

3.10 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.11 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.
B. Measure entering and leaving air temperatures.
C. Record compressor data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature

3.13 TOLERANCES

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

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.

3.14 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.

3. Project name.
4. Project location.
5. Outdoor air wet buld and dry buld temperatures in deg F
6. Architect's name and address.
7. Engineer's name and address.
8. Contractor's name and address.
9. Report date.
10. Signature of TAB supervisor who certifies the report.
11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
12. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

13. Nomenclature sheets for each item of equipment.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Coil, wet- and dry-bulb conditions.
    d. Fan drive settings including settings and percentage of maximum pitch diameter.
    e. Settings for supply-air, static-pressure controller.
    f. Other system operating conditions that affect performance.

D. Heat Recovery unit, fan coil unit, and Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Coil static-pressure differential in inches wg.
g. Outdoor airflow in cfm
h. Return airflow in cfm
i. Relief airflow in cfm
j. Outdoor-air damper position.
k. Return-air damper position.
l. Relief-air damper position.

4. Plat heat exchanger test report
a. Exhaust entering and leaving air temperature in deg F
b. Outside air and supply entering and leaving air temperature in deg F
c. Face and bypass damper possition

E. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Entering-air, wet- and dry-bulb temperatures in deg F.
f. Leaving-air, wet- and dry-bulb temperatures in deg F.
g. Water flow rate in gpm.
h. Water pressure differential in feet of head or psig.
i. Entering-water temperature in deg F.
j. Leaving-water temperature in deg F.

k. Refrigerant expansion valve and refrigerant types.
l. Refrigerant suction pressure in psig.
m. Refrigerant suction temperature in deg F.

F. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. Output capacity in Btu/h.
   b. Ignition type.
   c. Burner-control types.

2. Test Data (Indicated and Actual Values):

   a. Total air flow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
   d. Air temperature differential in deg F.
   e. Entering-air static pressure in inches wg.
   f. Leaving-air static pressure in inches wg.
   g. Air static-pressure differential in inches wg.
   h. Low-fire fuel input in Btu/h.
   i. High-fire fuel input in Btu/h.
   j. Manifold pressure in psig.
   k. High-temperature-limit setting in deg F.
   l. Operating set point in Btu/h.
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btu/h.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils, unit heaters, cabinet unit heaters, fin tube, and water coils of terminal units, include the following:

1. Unit Data:

    a. System and air-handling-unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.
    b. Entering-water temperature in deg F.
    c. Leaving-water temperature in deg F.
    d. Water pressure drop in feet of head or psi.
    e. Entering-air temperature in deg F.
    f. Leaving-air temperature in deg F

K. Boiler Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in Btu/h
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and rpm.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.

2. Test Data (Indicated and Actual Values):

    a. Low-fire fuel input in Btu/h.
    b. High-fire fuel input in Btu/h.
    c. Manifold pressure in psig.
    d. Water flow rate in gpm.
    e. Water pressure differential in feet of head or psig.
    f. Entering-water temperature in deg F.
    g. Leaving-water temperature in deg F
    h. Relief valve setting.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig .
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm (L/s).
j. Voltage at each connection.
k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

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

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 5 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

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

D. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

A. Provide additional TAB visits as required to accommodate project scheduling and phasing.

B. Within one year of completing TAB, perform two additional TAB visits to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

C. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 0713

DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed and exposed supply, return, and outdoor air in unconditioned space.
   2. Indoor, concealed supply, return, and outdoor air
   3. Outdoor, exposed supply and return

B. Related Sections:
   1. Division 23 Section "HVAC Piping Insulation."
   2. Division 23 Section "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

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

B. Detail application schedule of intended insulation type for each type of application.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

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

1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

C. Mineral-Fiber Blanket Insulation:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

D. Mineral-Fiber Board Insulation:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

E. Exterior flexible elastomeric with laminate sheet: Flexible, Closed-cell, elastomeric sheet with factory applied laminating. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide products by one of the following:

   a. ArmaCell- Arma-Tuff Plus Laminate Sheet
   b. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS

2. Material shall have a maximum thermal conductivity of 0.25 Btu-in/h-ft^2-F at a 75 dag F mean temperature when tested in accordance with ASTMC 177 or ASTM C 518, latest revisions.
3. Material shall be low VOC's, fiber free, dust free, and resist mold and mildew
4. Laminate: 12 mil
   a. Water vapor permeability:
      1) Laminate: 0
      2) Foam: .05 parm-inch
   b. Mold growth compliant with UL181
   c. Fungi Resistant compliant with ASTM G 21/C 1338
   d. Bacteria Resistance: ASTM G 22
   e. UV resistant
   f. Weather resistant
   g. Chemical Resistant

2.2 ADHESIVES

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

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according

C. ASJ and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller
2. Insulation finish shall be the insulation manufacturers recommended finish.
3. Adhesive shall be the insulation manufacturers recommended contract adhesives.
4. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
5. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Composition- synthetic rubber base with synthetic resins and fillers added

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
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. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
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. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 permsat 0.0625-inchdry 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.

2.4 LAGGING ADHESIVES

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. ASJ Flashing Sealants:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
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, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
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, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II

2.7 TAPES

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

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

B. 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, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ

2. Width: 3 inches
3. Thickness: 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. Laminate sheet tape: White vapor-retarder foil tape matching field-applied laminate with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Armacell ArmaTuff white seal tape
   b. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS

2. Width: 6 inches.
3. Thickness: 12 mils.
4. Tensile strength: 69 lb/in
5. Elongation: 80%
6. Puncture: 35 lbs

2.8 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins:

   a. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   b. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins:

   a. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   b. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

3. Insulation-Retaining Washers:

   a. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   b. Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   c. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

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

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

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

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

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings

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

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

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

3.4 PENETRATIONS

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

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping.

C. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. Draw jacket tight and smooth.
   b. 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.
   c. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c
   d. On rectangular duct sides with dimensions 24 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 18 inches O.C.
   e. On rectangular duct sides with dimensions larger than 24 inches, place pins 18 inches O.C. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing. Provide pins and clip washers at 18” O.C. in the bottom of duct, minimum of 2 rows longitudinally.
   f. On round ductwork at 24” diameter and greater provide pins and clip washers at 18” O.C. in both directions from the horizontal centerline of duct downward.
   g. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   h. Do not overcompress insulation during installation.
   i. Impale insulation over pins and attach speed washers.
   j. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   k. At all ductwork with external flanges, provide a 8” (min) piece of insulation wrapped around the duct, centered on the flange and securely taped.
   l. Sagging duct insulation will not be acceptable.
   m. Vapor retarders should overlap a minimum of two inches at all seams and be sealed with appropriate pressure sensitive tape. When applying pressure sensitive tapes, the tape must be firmly rubbed with the proper sealing tool to make sure the closure is secured. Follow tape manufacturers recommendations.
   n. For below ambient services, apply vapor-barrier mastic over staples
   o. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   p. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings

2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment.

Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch O.C. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

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

3. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches O.C.
4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches O.C.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On all duct sides, space pins 12 inches O.C. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
b. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
c. Do not overcompress insulation during installation.
d. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
e. Vapor retarders should overlap a minimum of two inches at all seams and be sealed with appropriate pressure sensitive tape. When applying pressure sensitive tapes, the tape must be firmly rubbed with the proper sealing tool to make sure the closure is secured. Follow tape manufacturers recommendations.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch O.C. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

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

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches O.C. Tape and seal all ends and joints.
7. Vapor retarders should overlap a minimum of two inches at all seams and be sealed with appropriate pressure sensitive tape. When applying pressure sensitive tapes, the tape must be firmly rubbed with the proper sealing tool to make sure the closure is secured. Follow tape manufacturers recommendations.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On all duct sides, space pins 12 inches O.C. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   b. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   c. Do not overcompress insulation during installation.
   d. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   e. When applying pressure sensitive tapes, the tape must be firmly rubbed with the proper sealing tool to make sure the closure is secured. Follow tape manufacturers recommendations
4. Seal all edges with pressure sensitive laminate sheet tape. When applying pressure sensitive tapes, the tape must be firmly rubbed with the proper sealing tool to make sure the closure is secured. Follow tape manufacturers recommendations

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and

inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches O.C. Tape and seal all ends and joints.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

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

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

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

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

3.8 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

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

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

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.
7. Exhaust ducts
8. Supply and return duct with an interior temperature difference to the exterior does not exceed 15 degrees F.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed and concealed, rectangular and round, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Board: 3 inches thick and 2-lb/cu. ft. nominal density, with factory applied ASJ paintable jacket material.

B. Concealed, rectangular and round, supply duct insulation shall be the following:

1. Mineral-Fiber blanket: 2 inches thick and .75-lb/cu. ft. nominal density, with factory applied FSK paintable jacket material.

C. Exposed, rectangular and round, supply air duct insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density, with factory applied ASJ paintable jacket material

3.11 OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, rectangular and round, supply and return duct insulation shall be the following:
1. Exterior flexible elastomeric with factory bonded laminate sheet: 2 inches thick, with factory applied and bonded laminate sheet. extend insulation through the exterior wall and terminate 24 inches inside the building.

END OF SECTION

SECTION 23 0718

REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Refrigerant suction, refrigerant liquid, and hot-gas piping, indoors and outdoors.

B. Related Sections:
   1. Division 23 Section "Duct Insulation."
   2. Division 23 Section "HVAC Piping Insulation Piping."

1.3 ACTION SUBMITTALS

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

B. Detail application schedule of intended insulation type for each type of applications.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

E. Flexible Elastomeric Insulation: Closed-cell, antimicrobial sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
2. Fiber free, formaldehyde free, low VOC and non particulating
3. Built-in vapor barrier
4. Upper use limit- 220 deg F
5. Lower use limit- -297 deg F

6. Water vapor permeability- .08 perm-in
7. Thermal conductivity- .286 BTU*in/h*ft^2*deg F at a mean temperature of 90 deg F.
8. Color- Black

2.2 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. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White
   c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      1) 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

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F.
   c. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   d. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F.
   c. Solids Content: 60 percent by volume and 66 percent by weight.
   d. Color: White

2.4 TAPES

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Width: 2 inches
3. Thickness: 6 mils
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width

2.5 ADHESIVES AND JOINT SEALANT

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.

1. Small-Scale Environmental Chambers," including 2004 Addenda.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller
2. Insulation finish shall be the insulation manufacturers recommended finish.
3. Adhesive shall be the insulation manufacturers recommended contract adhesives.
4. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Use adhesive that 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," including 2004 Addenda.
6. Composition- synthetic rubber base with synthetic resins and fillers added.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

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

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

I. 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. 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

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

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

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

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

3.4 PENETRATIONS

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

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

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

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

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Install pipe insulation by slitting tubular section and applying to tubing. Slide unslit sections over open ends of piping. Seal all seams and butt joints.
1. Insulation shall be pushed onto piping – never pulled.
2. All edges shall be clean cut.

C. Insulation Installation on Flanges and Fittings:
1. All fittings shall be same thickness as adjacent piping.

D. 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.

E. 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.
5. Openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engag**e** a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings 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 and three locations of 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.

3.7 INDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction, Refrigerant Liquid, and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1 1/2 inches thick.

3.8 OUTDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction, Refrigerant Liquid, and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
2. Flexible Elastomeric: 1 1/2 inches thick with PVC jacket

END OF SECTION

SECTION 23 0719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Heating hot-water piping, indoors.

B. Related Sections:

1. Division 23 Section "Duct Insulation."

1.3 ACTION SUBMITTALS

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

B. Detail application schedule of intended insulation type for each type of applications.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

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

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fibrex Insulations Inc.; Coreplus 1200.
    b. Johns Manville; Micro-Lok.
    c. Knauf Insulation; 1000-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.
    a. Thermal conductivity (k) to not exceed 0.27 BTU per inch/h*ft^2*F

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

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA, Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
2. Fiber free, formaldehyde dree, low VOC and non particulating
3. Built-in vapor barrier
4. Upper use limit- 220 deg F
5. Lower use limit- -297 deg F
6. Water vapor permeability- .08 perm-in
7. Thermal conductivity- .286 BTU*in/h*ft^2*deg F at a mean temperature of 90 deg F.
8. Color- Black

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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.

1. Small-Scale Environmental Chambers," including 2004 Addenda.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller
2. Insulation finish shall be the insulation manufacturers recommended finish.
3. Adhesive shall be the insulation manufacturers recommended contract adhesives.
4. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
5. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Composition- synthetic rubber base with synthetic resins and fillers added.

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. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F.
   c. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   d. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F.

c. Solids Content: 60 percent by volume and 66 percent by weight.
d. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Permanently flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 100 to plus 300 deg F.
   d. Color: White or gray.
2. 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).

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F.
   d. Color: White.
2. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.7 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. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White

c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   1) 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.

2.8 TAPES

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

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

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Width: 2 inches
3. Thickness: 6 mils
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Staples:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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.

   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.

3.4 PENETRATIONS

A. 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.

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

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

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

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 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. 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. 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 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.

3.7 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. Install pipe insulation by slitting tubular section and applying to tubing. Slide unslit sections over open ends of piping. Seal all seams and butt joints.
1. Insulation shall be pushed onto piping – never pulled.
2. All edges shall be clean cut.

C. Insulation Installation on Flanges and Fittings:
1. All fittings shall be same thickness as adjacent piping

D. 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.

E. 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.

F. Insulation Installation on Valves and Pipe Specialties:

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

3.8 FIELD-APPLIED JACKET INSTALLATION

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

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

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engag**e** 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.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

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.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate piping and equipment drain water :

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

a. Flexible elastomeric: 1 inch thick

B. Heating-Hot-Water supply and return piping, 200 Deg F and Below:

1. NPS 1-1/2 and smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick with factory applied ASJ jacket and PVC fitting covers.

2. NPS 2 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inch thick with factory applied ASJ jacket and PVC fitting covers.

C. Heating-Hot-Water supply and return piping, 200 Deg F and Below located within the bus wash and chassis wash bays:

1. NPS 1-1/2 and smaller: Insulation shall be the following:

a. Flexible elastomeric, 1-1/2 inch thick and field applied PVC jacketing.
1) PVC: 30 mils thick, white

2. NPS 2 and Larger: Insulation shall be the following:

a. Flexible elastomeric, 1-1/2 inch thick and field applied PVC jacketing.
1) PVC: 30 mils thick, white

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

END OF SECTION

SECTION 23 0900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Related Sections include the following:

1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. GUI: Graphic User Interface

C. I/O: Input/output.

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

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

F. PC: Personal computer.

G. PID: Proportional plus integral plus derivative.

H. RTD: Resistance temperature detector.

1.4 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents. The workstation shall display dynamic, real-time point data on color graphic displays for all points. Provide all required software and hardware. Provide wiring and conduit required to connect devices furnished as a part of, or accessory to, this automatic control system.

B. The Building Management System (BMS) shall be as indicated on the drawings and described in these specifications. System must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and installed in the equipment manufacturer's factory as specified in those sections. The intent of the BMS is to integrate all mechanical equipment into one system for global monitoring, control, and alarming associated with the building. BMS manufacturer authorized representative is responsible to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BMS operators have the capability of managing the building mechanical system to ensure occupant comfort while maintaining energy efficiency

C. The BMS shall meet open protocol communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BMS manufacturers in future projects

D. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and terminal devices on this project.

E. The BMS 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

F. The mechanical systems and terminal devices shall be provided with factory mounted DDC controls that will permit each system to operate in a stand-alone fashion where indicated on drawing schedules. As such, in the event of a BMS network communication failure, or the loss of an individual controller, the other DDC controllers shall continue to independently operate and communicate to the BMS.

G. Communication between DDC controllers and all workstation(s) shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the controller identifier or location to view or control a point (object). Application Specific Controllers shall be constantly scanned by the Building Controllers to update point information and alarm information globally

H. The BMS manufacturer authorized representative shall provide all hardware and software necessary to implement the functions and sequence of operations specified

I. Control wiring is defined as wiring up to and including 120 volts. Install wiring in accordance with requirements of "Electric Wiring" in Section 260519, and the National Electrical Code. Provide all required devices for proper system operation, including transformers, relays, pushbutton stations, etc. Provide all power distribution and breakers from panel boards to the control panels.

J. Freestanding panels shall be supported from "Unistrut" securely fastened to walls.

K. Provide Ethernet data drops at main building controller and at operator workstations

1.5 ACTION SUBMITTALS

A. BMS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. 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. Five (5) copies are required. All shop drawings shall be provided to the Owner electronically as .pdf file formats once they have been approved and as-built drawings have been completed

B. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

C. Submit for review the following:
   1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers
   2. Provide all manufacturers' technical cut sheets for major system components. When technical 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.
   3. Each submitted product literature and drawings shall clearly reference the specification page and section number and/or drawing number associated with the product. Include:
      a. Building Controllers
      b. Custom Application Controllers
      c. Application Specific Controllers
      d. Operator Workstations
      e. Portable Operator Terminals
      f. Auxiliary Control Devices
      g. Proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.
      h. Detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
      i. Points list showing all system objects and the proposed English language object names.
      j. Sequence of operation for each controlled mechanical system and terminal end devices.
      k. Provide a Protocol Implementation Conformance Statement (PICS) for each system level device (i.e. Building Controller & Operator Workstations) type. This defines the point list for proper coordination of interoperability with other building systems if applicable for this project.
      l. Provide Certification and functional profile SNVT's for unitary-level controllers (i.e. chillers, RTU's, AHU's, Terminal VAV boxes, FCU's, UV's, etc.) for interoperability with other building systems if applicable for this project.

4. Detailed piping and wiring control diagrams and systems description for each system under control.
5. Detailed layout and nameplate list for component control panels and DDC panels.
6. Submit a valve, actuator, and damper scheduled showing size, manufacturer, model number, pressure drop configuration, capacity, and locations. Provide apparatus Bulletins and data sheets for all control system components.
7. Submit an airflow station schedule showing size, manufacturer, model number, airflow, velocity, and locations.
8. A complete listing of input and output points, control loops and/or routines, including time of day functions, and facilities management system functions for each controlled system. This listing shall include point logical names, identifiers, and alarmable ranges.
9. Provide as part of a separate submittal a hard copy of all graphics showing system components, sensor locations, setpoints and fixed/variable data. Engineer shall review and approve graphic format prior to final acceptance of system.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

1.7 CLOSEOUT SUBMITTALS

A. Upon completion of installation, submit three (3) copies 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 and .pdf files shall also be provided.
2. Testing Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BMS) commissioning personnel
3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:
   a. Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
   b. Procedures for operating the BMS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements
   c. Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.
   d. Explanation of how to design and install new points, new DDC controllers, and other BMS hardware.
   e. Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.
   f. Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.
   g. One set of electronic media containing files of all operator color graphic screens for the project.

h. A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.
i. Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
j. Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
k. Licenses, Guarantee, and Warranty documents for all equipment and systems.
l. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) and task descriptions

1.8 QUALITY ASSURANCE

A. The BMS manufacturer authorized representative shall have an established business office within 50 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.

B. The BMS Manufacturer authorized representative shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BMS manufacturer authorized representative shall be able to provide training certifications for all local office personnel upon request.

C. The BMS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BMS manufacturer.

D. Multiple independent representatives of BMS manufacturers are not acceptable. BMS vendor must be corporate owned authorized representative entity of BMS manufacturer.

E. The complete automatic temperature control system shall be comprised of electric control devices with a microprocessor based Direct Digital Control System. All work shall be installed only by skilled mechanics employed by the BMS Manufacturer authorized representative temperature control contractor or subcontractor.

F. The BMS Manufacturer authorized representative installer shall have a minimum of five years experience in systems of similar size, type and complexity installed within a 50 mile radius.

G. All components shall be fully tested and documented to operate as a complete system.

H. Supplier must guarantee that all replacement parts will be carried in stock for a period of 5 years minimum from the date that the system is commissioned.

I. All products used in this installation shall be currently manufactured, and shall have been applied to a minimum of three previous projects. 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.

1.9 CONTROL SYSTEM GUARANTEES/WARRANTY

A. BMS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BMS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BMS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).

B. 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 BMS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

C. 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 the Owner must be granted prior to the installation of these updates

D. The BMS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, graphics library, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

1.10 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion)
   1. Make a minimum of 4 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:
      a. System Review – Review the BMS to correct programming errors, failed points, points in alarm, and points that have been overridden manually
      b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads.
      c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified
      d. Database back-up
      e. Operator coaching
   2. Technician shall review critical alarm log and advise owner of additional services that may be required
   3. Technician shall provide a written report to owner after each inspection

B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

1.11 SYSTEM ADJUSTMENT AND CALIBRATION

A. When the Work has been completed, completely adjust and calibrate the control system upgrades. Review the operation of each system input and output, control loops and/or software routings, timing functions, operator entered constants and facilities management functions and observe that they perform their intended functions. When above procedure has been completed

and the control system is operating satisfactorily, submit a letter with one copy of completed values and points log to the Owner's Representative advising them that the control system is 100% complete and operates in accordance with the Contract Documents

1.12 INSTRUCTIONS TO THE OWNER'S REPRESENTATIVE

A. Provide competent control technicians to instruct the Owner's operating personnel and turn over three copies of maintenance manual. Provide a total of 24 hours of instruction at the site, 16 hours during start-up and 8 hours after six months. Instruction sessions shall be scheduled at the owner's convenience and shall be limited to four (4) hours per session.

B. Training Manuals: The BMS manufacturer shall provide a course outline and copies of training manuals at least two weeks prior to the start of any corporate training class to be attended by the Owner.

C. All project developed hardware and software shall become the property of the Owner. This includes but is not limited to:
   1. Operator Graphic files
   2. As-built hardware design drawings
   3. Operating & Maintenance Manuals
   4. BMS System software database
   5. Controller application programming databases
   6. Application Specific Controller configuration files
   7. Required Licensed software

1.13 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.14 COORDINATION

A. Coordinate location of thermostats, carbon dioxides sensors, pressure sensors, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment location.

C. Coordinate supply of conditioned electrical branch circuits and power requirements for control units and operator workstation.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

2.2 MANUFACTURER

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to:
   a. Andover Controls Corp
   b. Carrier
   c. Honeywell International Inc.; Home & Building Control
   d. Johnson Controls, Inc.; Controls Group
   e. Siemens Building Technologies, Inc

2.3 CONTROL DEVICE

A. Control Valve

1. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

2. Sized by temperature control manufacturer and guaranteed to meet the heating and cooling requirements. Water valves shall be sized on the basis of 15% of the total system pressure drop, but not more than 10 ft. of head drop. Pressure drop for valves shall be submitted for review, including all CV values.

3. Valves shall be equal percentage type, equipped with characteristic type throttling plug, #316 stainless steel or Monel stem, removable composition discs, and EDPM seats. Provide with necessary features to operate in sequence with other valves or damper operators and adjustable throttling range as required by the sequence of operations.

4. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

   a. Water Valves:

      1) Two-way: 150% of total system (pump) head.

      2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head

5. NPS 2” and Smaller: Globe Valves, bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Valves shall have allowable media temperature of 20°F to

281°F to assure that the valve packing will have a long life (valves will narrower allowable media temperatures have no reserve packing capability for long term watertight seal).

6. NPS 2-1/2” and Larger: Globe Valves, iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

7. Hydronic system globe valves shall have the following characteristics:

   a. Rating: Class 125 for service at 125 psig. and 250°F operating conditions.

   b. Internal Construction: Replaceable plugs and seats of stainless steel or brass.

      1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.

      2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

   c. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

   d. Water valves shall be sized on the basis of no more than 10 ft. of head drop.

B. Actuator

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. 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.
5. Actuators shall be provided with a conduit fitting and a minimum 18” electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
6. Actuators shall be Underwriters Laboratories Standard 873 listed.
7. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque
8. Valve

a. Provide modulating 24 VAC control operators that are 0-10 VDC input proportional with spring return as needed by control sequence and designed for water service valve bodies. Operator shall be synchronous motor driven and force sensor safety stop.
b. Provide two position 24 VAC control operators as needed by control sequence for unitary control such as heat pump control and designed for water service valve bodies. Operator shall be synchronous motor driven and force sensor safety stop.
c. Run time: 60 seconds or less

9. Damper

a. Electronic Damper Actuators: Direct-coupled type non hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper.

1) Coupling: V-bolt and V-shaped, toothed cradle.
2) Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3) Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4) Actuators shall have the ability to be tandem mounted.
5) All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
6) Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
7) Power Requirements (Modulating): Maximum 15 VA at 24V ac.
8) Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9) Temperature Rating: -22°F to 140ºF.
10) Run Time: 200 seconds open, 40 seconds closed
11) Size for running torque calculated as follows, verify with damper manufacturer that damper actuators provide required torque to comply with leakage rate specifications for damper:

a) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
b) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
c) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
d) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
e) Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.
f) Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.

12) Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.

C. Safety/Status Devices

1. Low Limit Detector: Electric type, with 20' long serpentine element, with manual reset and auxiliary contacts to the DDC, set for 37°F for "freeze" protection and 55°F for fan discharge application. Provide a 20' long element for every 25 sq. ft. of coil face area.
2. High Limit Detector: Electric type, with manual reset and auxiliary contacts to the DDC, UL listed for fire, set for 180°F.
3. Pump status shall be provided through adjustable range current sensing element on pump motor.
4. Fan status shall be provided through adjustable range current sensing element on the fan motor

D. Miscellaneous Devices

1. Provide necessary, relays, transformers, cumulators, three-way air valves, positioners, pneumatic electric switches, air switches, required for a complete and operable system.
2. Locate these devices in a separate panel unless specified otherwise.

2.4 SYSTEM PERFORMANCE

A. Performance Standards. The BMS 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 operator's 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. 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 Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Table below lists minimum acceptable reporting accuracies for all values reported by the specified system

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

2.5 CONTROL CABINETS

A. Central DDC control panels shall be fully enclosed cabinet, baked enamel, steel, aluminum or composite material construction and shall meet the requirements of NEMA 1 enclosures. Panels shall have hinged door with a locking latch. Cover exposed electrical connections. Each component on front panel shall have an appropriate engraved label describing its function. Components inside the panel shall be appropriately labeled for ease of identification. Stick-on labels are not acceptable. Panels shall be either free-standing or wall-mounted. Provide support steel framing.

2.6 DIRECT DIGITAL CONTROL SYSTEM

A. The basic elements of the Direct Digital Control System structural shall consist of standard components kept in inventory by the equipment supplier. The components shall not require customizing other than setting jumpers and switches, adding firmware modules or software programming to perform required functions. The system may be expanded to its full capacity by adding sensors and entering programs in available random access memory (RAM). Future expansion shall not require hardware modifications to the controller. The entire system shall be a Direct Digital processing type.

B. The DDC system shall consist of the following:

1. Central DDC panels (UNC).
2. Application specific controllers (ASCI).
3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel (Central or ASC) shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.7 Central DDC panels shall be able to access any data form, send control commands and alarm reports directly to any other DDC panel, operator workstation, or printer on the network

2.8 ARCHITECTURE/COMMUNICATION

A. This project shall be comprised of a high speed Ethernet network communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall utilize open protocol communications.

1. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using open protocol communication.
2. The Owner will provide all communication media, connectors, repeaters, network switches, and routers necessary for the high speed Ethernet network. An active Ethernet port will be provided adjacent to each System Controller and operator interface (PC) for connection to this high speed Ethernet network.
3. All values within the system (i.e. schedules, datalogs, points, software variables, custom program variables) shall be readable and controllable (where appropriate) by any System Controller
4. Provide all required convertor control panels between equipment manufacturer supplied controllers and BMS to allow for required communication. Example includes Modbus to BACnet convertors.

B. Wireless equipment controllers and auxiliary control devices shall conform to:'

1. IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
2. Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. (762 m) with less than 2% packet error rate.
3. To check for proper operation, wireless zone temperature sensors shall include a signal strength and battery condition indicators on the zone sensor display or using LED's on non-display models.
4. To maintain robust communication, two-way communications shall be used between the wireless zone sensor and receiver to allow channel switching based on varying channel traffic and signal strength.
5. The wireless zone sensor and receiver addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
6. The wireless zone sensor and receiver shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.
7. Installation and replacement of failed sensors shall be accomplished automatically after power up.
8. To allow local troubleshooting without specialized tools, error codes shall be displayed on the digital display through a blinking pattern on the non-display models. Error codes shall include: not associated, address to 000, improper software configuration, input voltage too high, or general sensor failure. Codes shall be indicated on inside of sensor back cover.
9. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E

2.9 OPERATOR INTERFACE

A. Furnish (1) PC based operator interface as shown on the system drawings. Each of these operator interfaces shall be able to access all information in the system. The operator interface shall reside on the Enterprise wide network, which is same high-speed communications network as the System Controllers. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP).
   1. Each PC based operator interface shall include the following
      a. Hardware type
         1) PC
         2) Laptop
      b. Operating Systems
         1) Windows XP
         2) Windows 7
      c. Minimum Hardware
         1) Pentium Core 2 DUO or better
         2) 4 GB RAM
         3) 100 GB hard drive space
         4) Internet Browser compatible with operator interface requirements outlined in the operator interface section
         5) Java Runtime Environment (JRE) V6.0 or higher

B. Operator Interface
   1. The operator interface shall be accessible via a web browser.
   2. The operator interface shall support the following Internet web browsers:
      a. Internet Explorer latest version
      b. Firefox latest version
      c. Chrome latest version
   3. The operator interface shall support the following mobile web browsers:
      a. Latest version of apple iOS
      b. Latest version of Android

C. Mobile App Operator Interface
   1. Mobile App Operator Interface shall support the following Operating systems
      a. Latest version of apple iOS
      b. Latest version of Android
   2. The operator interface shall support system access on a mobile device via a mobile app to:
      a. Alarm log
      b. System Status
      c. Equipment status
      d. Space Status
      e. Standard Equipment graphics
   3. The operator interface shall support actions on a mobile device via a mobile app to:
      a. Override set points
      b. Override occupancy
      c. Acknowledge Alarms
      d. Comment on Alarms

D. System Security

1. Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.
2. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
3. Each operator shall be allowed to change their user password
4. The System Administrator shall be able to manage the security for all other users
5. The system shall include pre-defined "roles" that allow a system administrator to quickly assign permissions to a user.
6. User logon/logoff attempts shall be recorded.
7. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
8. All system security data shall be stored in an encrypted format.

E. Database
1. Database Save. A system operator with the proper password clearance shall be able to archive the database on the designated operator interface PC.
2. Database Restore. The system 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.

F. On-Line Help and Training
1. Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.
2. On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.

G. System Diagnostics
1. The system shall automatically monitor the operation of all network connections, building management panels, and controllers.
2. The failure of any device shall be annunciated to the operators

H. Equipment & Application Pages
1. The operator interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
2. Animated Equipment Graphics for each major piece of equipment and floor plan in the System. This includes all scheduled equipment.
   a. These graphics shall show all points dynamically as specified in the points list
   b. Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.
3. Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
4. Historical Data (As defined in Automatic Trend Log section below) for the equipment or application without requiring a user to navigate to a data log page and perform a filter

I. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point

1. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.
2. Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
3. Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.
4. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
5. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash)

J. Custom Graphics
1. The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.
2. Graphical Navigation. The operator interface shall provide dynamic color graphics of building areas, systems and equipment.
3. Graphical Data Visualization. The operator interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.
4. Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG

K. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program

L. Manual Control and Override
1. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.
2. Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
3. Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.
4. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually

M. Engineering Units
1. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
2. Unit selection shall be able to be customized by locality to select the desired units for each measurement.
3. Engineering units on this project shall be IP

N. Scheduling. A user shall be able to perform the following tasks utilizing the operator interface:
1. Create a new schedule, defining the default values, events and membership.
2. Create exceptions to a schedule for any given day.
3. Apply an exception that spans a single day or multiple days.
4. View a schedule by day, week and month.
5. Exception schedules and holidays shall be shown clearly on the calendar.
6. Modify the schedule events, members and exceptions

O. Trend logs
1. Trend Logs Definition
   a. The operator interface shall allow a user with the appropriate security permissions to define a trend log for any data in the system.
   b. The operator interface shall allow a user to define any trend log options as described in the Application and Control Software section
2. Trend Log Viewer
   a. The operator interface shall allow Trend Log data to be viewed and printed.
   b. The operator interface shall allow a user to view trend log data in text-based (time –stamp/value).
   c. The operator shall be able to view the data collected by a trend log in a graphical chart in the operator interface.
   d. Trend log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
   e. Each data point trend line shall be displayed as a unique color.
   f. The operator shall be able to specify the duration of historical data to view by scrolling and zooming.
   g. The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis
3. Export Trend Logs
   a. The operator interface shall allow a user to export trend log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages

P. Alarm/Event Notification
1. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
2. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator interface.
   a. The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories based on severity.
   b. Alarm/event messages shall use full language, easily recognized descriptors.
   c. An operator with the proper security level may acknowledge and clear alarms/events.
   d. All alarms/events that have not been cleared by the operator shall be stored by the building controller.
   e. The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.
3. Alarm Processing.
   a. The operator shall be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.
   b. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system

Q. Reports and Logs

1. The operator interface shall provide a reporting package that allows the operator to select reports.
2. The operator interface shall provide the ability to schedule reports to run at specified intervals of time.
3. The operator interface shall allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:
   a. CSV, HTML, XML, PDF
4. Reports and logs shall be readily printed to the system printer.
5. Provide a means to list and access the last 10 reports viewed by the user.
6. The following standard reports shall be available without requiring a user to manually configure the report:
   a. All Points in Alarm Report: Provide an on demand report showing all current alarms.
   b. All Points in Override Report: Provide an on demand report showing all overrides in effect.
   c. Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
   d. Points report: Provide a report that lists the current value of all points

2.10 APPLICATION AND CONTROL 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 interface

1. 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:
   a. Weekly Schedule. Provide separate schedules for each day of the week.
   b. 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.
   c. 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.
   d. Optimal Start. The scheduling application outlined above shall support an optimal start 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 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
2. Trend Log Application

a. Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a Workstation for longer term storage
   1) Trend logs shall include interval, start-time, and stop-time.
   2) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year
b. Automated Trend Logs
   1) The system controller shall automatically create trend logs for defined key measurements for each controlled HVAC device and HVAC application.
   2) The automatic trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
   3) Coordinate with owner for final automatic trending parameters.
c. Alarm/Event logs
   1) Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state
   2) Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system
   3) An alarm/event shall be capable of triggering any of the following actions
      a) Route the alarm/event to one or more alarm log- The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself
      b) Route an e-mail message to an operator(s)
      c) Log a data point(s) for a period of time
      d) Run a custom control program
   4) Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events
   5) Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the operator interface
   6) Anti-Short Cycling. All binary output points shall be protected from short cycling

2.11 SYSTEM CONTROLLERS

A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.
   1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
   2. The controller shall provide a USB communications port for connection to a PC
   3. 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.
   4. All System Controllers shall have a real time clock.
   5. Data shall be shared between networked System Controllers.
   6. The System 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.

c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
d. Automatically reset the System Controller to return to a normal operating mode

7. 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 -40 C to 50 C [-40 F to 122 F]
8. Clock Synchronization
   a. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
   b. All System Controllers shall be able to accept a time synchronization command for automatic time synchronization.
   c. All System Controllers shall automatically adjust for daylight savings time if applicable
9. Serviceability
   a. Provide diagnostic LEDs for power, communications, and processor.
   b. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
   c. All wiring connections shall be made to field removable, modular terminal connectors.
   d. The System controller shall utilize standard DIN mounting methods for installation and replacement
10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller
11. 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
12. Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the Test Labs

2.12 PROGRAMMABLE CONTROLLERS

A. For Stand-Alone Operation the Central Plant and Air Handling Controllers Shall:
   1. Operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup
      a. The Controller shall have a built in schedule (assessable with or without a display)\
      b. Support will be for at least 3 schedules with up to 10 events for each day of the week.
      c. Each of the 3 schedules can be Analog, Binary or Multi-State
      d. The controller shall support a minimum of 25 exceptions each with up to 10 events
   2. For ease of troubleshooting, the Controller shall support data trend logging
      a. 25,000 samples minimum
      b. Trends shall be capable of being collected at a minimum sample rate of once every second
      c. Trends shall be capable of being scheduled or triggered
   3. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller
   4. Environment. Controller hardware shall be suitable for the anticipated ambient conditions
      a. Storage conditions:

1) Temperature: -67°F to 203°F (-55°C to 95°C)
2) Humidity: Between 5% to 100% RH (non-condensing)

b. Operating conditions
1) Temperature: -40°F to 158°F (-40°C to 70°C)
2) ‘Humidity: Between 5% to 100% RH (non-condensing)

c. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum

d. 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 F to 158 F [-40 C to 70 C]

5. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements:

a. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.

b. Shall support flexibility in sensor type, the Controller shall be of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.

c. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.

d. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.

e. The controller support pulse accumulator for connecting devices like energy meters.

f. In order to support a wide range of devices, the Controller’s binary output shall be able to drive at least 10VA each.

g. Any I/O that is unused by functionality needed for the equipment shall be available to be used by custom program on the Controller and by any other controller on the network.

h. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.

i. The Controller shall provide a dedicated static pressure input

6. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs

a. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.

b. Expansion I/O can be mounted up to 200m from control

c. Expansion I/O can be added in as small as 4 point increments.

d. To keep MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the MS/TP network is not allowed)

7. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.

a. Diagnostic LEDs for power/normal operation/status, open protocol communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.

b. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box

c. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on protocol link and through the Controller's zone sensor.
d. For configuration, programming, and testing of controller programs must, for safety purposes, be able to be accomplished with the power off to the equipment and the controller.
e. The Controller software tool service port shall utilize standard of-the-shelf USB printer cable.
f. Capabilities to temporarily override the point values with built-in time expiration in the Controller.
g. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.
h. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
i. To aid in service replacement, the Controller shall allow for setting its address must be rotary switches that correspond to a numerical value for the address to allow the setting of the address without the need of a service tool or the control being powered (DIP switch methodologies are not allowed).
j. Controller data shall persist through a power failure

8. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
9. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output
10. Controller must meet the following Agency Compliance:
    a. UL916 PAZX, Open Energy Management Equipment
    b. UL94-5V, Flammability
    c. FCC Part 15, Subpart B, Class B Limit
    d. cUL Marked for international compliance
    e. CE Marked for international compliance

2.13 APPLICATION SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which through hardware or firmware design control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve

B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone

C. Software
1. To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
2. Stand-Alone Operation: Each piece of equipment identified on in the drawing schedules to have stand-alone controllers shall be controlled by a single controller and provide stand-alone control in the event of communication failure. In case of communications

failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.

3. For controlling ancillary devices and for flexibility to change to sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language

D. Environment Controller hardware shall be suitable for the anticipated ambient conditions
   1. Storage: -55 to 203 ^{0}F (-48 to 95^{0}C) and 5 to 95% Rh, non-condensing.
   2. Operating: -40 to 158 ^{0}F (-40 to 70 ^{0}C) and 5 to 95% Rh, non-condensing.
   3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum
   4. 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 F to 158 F

E. Input/Output
   1. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
   2. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
   3. For flexibility in selection and replacement of binary sensors, the controller shall support dry and wetted (24VAC) binary inputs.
   4. For flexibility in selection and replacement devices, the controller's shall have binary output which are able to drive at least 12VA each.
   5. For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
   6. For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.

F. Serviceability – The controller shall provide the following in order to improve serviceability of the controller
   1. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, protocol communications, and I/O communications bus.
   2. All binary output shall have LED's indicating the output state.
   3. All wiring connections shall removable without the use of a tool.
   4. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on protocol link and through the controller's zone sensor.
   5. For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
   6. Capabilities to temporarily override of point values with built-in time expiration in the controller.
   7. Mack Address shall be set using decimal (0-9) based rotary switches.
   8. Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
   9. Trending objects resident on controller
      a. Minimum of 20,000 trending points total on controller
      b. Shall be capable of trending all points used by controller
      c. Shall be capable of 1 second sample rates on all points

G. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

H. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.

I. Agency Approval: The controller shall have meet the Agency Compliance:
1. UL916 PAZX, Open Energy Management Equipment
2. UL94-5V, Flammability
3. FCC Part 15, Subpart B, Class B Limit

2.14 AUXILIARY EQUIPMENT/DEVICES

A. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors: Platinum, thermistors, or Balco.
2. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than .225°F maximum error of no more than .36°F.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
5. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

8. Space Temperature Sensors: Space temperature sensors shall be 5000 or 10,000 ohm thermistor type with wall plate adapter and blank cover assembly. Space temperature sensors shall include temperature adjustment and occupancy overrides where shown on the plans. Space temperature sensors shall be mounted 60 in. above the finished floor surface.
   a. Space sensors shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings
   b. The space temperature, setpoint, and override confirmation will be annunciated by a digital display for each zone sensor. The setpoint will be selectable utilizing buttons
   c. Room Security Sensors: Stainless steel cover plate with insulated back and security screws

B. Differential Fluid Pressure Sensor: Pressure range to suit application. Accuracy of 0.25%. Maximum working pressure of 250 psig. Maximum differential and static pressure shall be 250% of rated range. Type 304 stainless steel construction. 100% solid state dual diffused piezoresistive silicon sensing elements compatible with all medusa encountered in HVAC applications. Factory calibrated and tested. Easily accessible adjustments for zero and

span. 1/8 in. NPT pressure port connections. Input limiting capability by precisely clipping to transducers output. Adjustable output averaging from 1 to 10 seconds. Provide an external regulated power supply. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.

1. Make: Setra #C230.

C. Humidity Sensors: Bulk polymer sensor element.

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 F to 170 F.
4. Humidity sensor's drift shall not exceed 1% of full scale per year

D. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

1. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
2. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
3. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjustable

F. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

G. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

H. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

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. Carbon Dioxide Sensors shall have 0 to 10 volt DC or 4-20mA signal output, non-dispersive infrared operation, two (2) minute response time, wall-mount type. Carbon dioxide sensors shall be mounted 60 in. above the finished floor surface

K. 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

L. 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

M. 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.

N. Power Monitors
1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, + 0.5 Hz, voltage input range 120–600 V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required

O. Local Control Panels
1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
2. Interconnections between internal and face-mounted devices shall be 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 terminations for field connection shall be individually identified per control drawings.
3. Provide on/off power switch with over-current protection for control power sources to each local panel

P. Thermal dispersion airflow/pressure sensor and transmitter

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ebtron (basis of design)
   b. Ruskin
   c. Greenheck
2. Sensor
   a. Description- bi birectional airflow and pressure measurement, utilizing hermetically sealed three “bead-in-glass” thermistors to determine the airflow rate, direction, and temperature at each sensing location.
   b. Connector configuration- Type B: 1 to 4 bleed sensors
   c. Sensor accuracy
      1) Airflow: +-2% of reading, +-0.25% repeatability
      2) Temp: +-0.15 degree F
   d. Sensor range
      1) Velocity: -3000 to +3000 fpm
      2) Temperature: -20 degrees F to 160 degrees F
      3) Humidity: 0 to 99% rh, non condensing
   e. Sensor assembly
      1) Heated element: two bead-in-glass, hermetically sealed thermistor elements
      2) Temperature sensor: One bead-in-glass, hermetically sealed thermistor element
      3) Sensor potting material: Marine grade, waterproof epoxy
   f. Dimensions
      1) Length- 3.75 in
      2) Height- 1 in
      3) Width- 2.625 in
      4) Pipe fitting connections- .5 in female NPT
   g. Cable assembly
      1) Type UL plenum rated PVC jacket
      2) Length: 50 ft
      3) Termination: 0.875 in plug [transmitter end], gold plated pins
   h. Provide wall mounting kit to include 304 stainless steel face plate with stainless steel screen, male NPT reducer, and a right elbow and am NPT male pipe.
   i. Warranty
      1) 36 months
3. Transmitter
   a. Description- airflow and pressure transmitter capable of processing up to 4 individual bleed sensors. Provide direct communication with building management system via Ethernet or analog interface.
   b. Transmitter to include 16 character LCD display that indicates airflow/equivalent pressure, temperature and system status.
   c. Filed configuration and diagnostic to be accomplished through a push button interface on the main circuit board fir selection of units of measure, display units, output scaling, dampening filter, diagnostics and instrument status. Individual sensor airflow and temperature measurements can be displayed.
   d. Provide an output offset and gain adjustment feature to be engaged for installation where field calibration or adjustment is necessary.
   e. Calibrated airflow range
      1) Velocity: -3000 to +3000 fpm
      2) Pressure range: -.05 to +.05 in WC

3) Airflow calibration: TO NIST traceable standards
4) Temperature range: -20 degrees F to 160 degrees F
5) Humidity range: 0 to 99% (non-condensing)
6) Power requirements: 24 VAC at 12 to 13.1 VA

f. Transmitter enclosure
1) Transmitter construction: heavy duty with industrial grade IC's and rugged aluminum chassis with sliding cover
2) Transmitter dimensions:
a) Height: 9.251 in
b) Width: 6.688 in
c) Depth: 2.5 in
3) Transmitter mounting: Four .188 in diameter mounting holes on integral mounting plate

g. Output interface:
1) Analog outputs: Isolated analog 0-5/0-10 VDC or 4-20 mA linear
2) Analog output resolution: 0-10 VDC: 0.10 % of full scale; 0-5VDC: 0.20% of full scale
3) 10 Base-T Ethernet output: Field selectable BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP
4) Repeatability: 0.25% of reading
5) Field calibration wizard: Automated 1 or 2 point adjustment to factory calibration
6) Airflow output signal filter: Field adjustable 0 to 99% (via push-button interface)
7) Airflow low limit cutoff: forces output to zero below user-specified value
8) Programmable alarm: Alarm (dry relay contacts or LED drive) for user defined hi/low limit, setpoint with hysteresis for airflow transmitter/probe fault conditions.

2.15 SURGE SUPPRESSION (SP) RECEPTACLE

A. Provide at each DDC panel and operator workstation locations, a surge suppression receptacle with metal oxide varister to dissipate the electrical energy of voltage spikes. 20 ampere, duplex, NEMA 5-20R configuration. Back and side wiring, high impact nylon body.

B. Acceptable Make: Hubbell 5352-S

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

A. The Contract Documents shall be thoroughly examined for coordination of control devices their installation, wiring, and commissioning. Coordinate and review mechanical equipment

specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started

B. The BMS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started

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

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

E. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

F. Install automatic dampers according to Section 233300 "Air Duct Accessories."

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

H. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

I. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."

J. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

3.3 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 National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, 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 control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures

E. All control device installation, and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met
   1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
   2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose)

B. Do not install Class 2 wiring in conduits containing Class 1 wiring

C. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using industry approved fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.

D. 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.

E. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BMS manufacturer shall provide step-down transformers to achieve the desired control voltages.

F. All control 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.

G. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.

H. Conduit and wire sizing shall be determined by the BMS manufacturer in order to maintain manufacturer’s recommendation and must meet National and Local Codes.

I. Control and status relays are to be located in pre-fabricated enclosures that meet the application. These relays may also be located within packaged equipment control panel enclosures as coordinated. These relays shall not be located within Class 1 starter enclosures.

J. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring

K. BMS manufacturer 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 liquid-tight 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, liquid-tight, flexible metal conduits shall be used.

M. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

N. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

O. Install signal and communication cable:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

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

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

3.5 GENERAL SYSTEM REQUIREMENTS

A. The control of each system shall be guaranteed to perform as described in the Sequence of Operation Section. Equipment, remote switches, in finished rooms shall be flush-mounted, if possible.

3.6 PROGRAMMING

A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BMS manufacturer shall provide a minimum of 25% spare memory capacity for future use

B. Software Programming

1. Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BMS manufacturer's responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations

C. BMS Operator's Interface

1. When Operator Workstation is specified, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Additionally, provide individual floor plans of the building allowing an operator to quickly view the overall floor plan area for any out of tolerance conditions that may need addressing. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation
2. The BMS manufacturer 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 data base, and any third party software installation and integration required for successful operation of the operator interface.
3. As part of this execution phase, the BMS manufacturer shall perform a complete test of the operator interface. Test duration shall be a minimum of (8) hours on-site. Tests shall be made in the presence of the Owner and/or Engineer.
4. Demonstration: A complete demonstration of the capabilities of the BMS system shall be performed by the BMS manufacturer's field personnel. The BMS manufacturer shall dedicate a minimum of (16) hours on-site with the Owner representatives, and Engineer to demonstrate a complete functional test of all the BMS system requirements, including demonstrating correct sequence f operation. This BMS demonstration shall constitute an acceptance inspection, and will represent the process of approving the BMS as designed and specified.

3.7 SYSTEM COMPONENTS

A. Valves: Union or flanged connected. Locate close to apparatus controlled with pipe reducers and increasers located closest to valve. Locate, arrange, and pipe per installation diagram.

B. Mounting height for all new room thermostats or sensors shall be 48 in. to the top of the cover or match existing if sensor is being replaced.

C. Locate thermostats or sensors on walls symmetrical with adjacent items. Verify exact room location to avoid doors, fixed an portable equipment. Install to minimize damage. Do not install adjacent to lighting dimmers or other heat generating equipment.

D. Dampers and Damper Operators: Tag dampers for proper location. Install per manufacturer's printed instruction as to motor size and quantity, linkage arrangement, drive connection point. Adjust to close tightly. Allow for conduit sleeve or blank space for roof fan dampers. Where ducts are insulated, set damper operators at least 2 in. away from side of duct to allow for insulation.

E. Thermometers: Provide with diagrams indicating exact locations prior to start of Work. Arrange for easy reading

3.8 FIRE/FAN SHUTDOWN

A. Provide a signal to stop air handling unit fans upon activation of the fire alarm system. Wiring to be directly to the individual motor starters, unless otherwise indicated on drawings.

B. Provide a signal to the DDC control system that the fire alarm system is activated.

3.9 LOW LIMIT SAFETY FUNCTIONS

A. Provide for all supply fan units. Wiring to be directly to the motor starter. Low limit shall be located as shown on drawings. Low limit shall: prevent fan from operating, set heating coils to full heat operate coil pumps, fully close the outside air damper, fully close the relief air dampers, open return air damper, and alarm DDC system until reset.

3.10 SYSTEM TESTING

A. At the time of installation, systems shall be tested for control device operation prior to the systems acceptance. A report of each systems performance shall be submitted to the Owner's Representative. The report shall include:
   1. Field verification and demonstration checklist of analog input calibration, analog output operation, digital input function, and digital output operation.
   2. Trend log of inputs and output, printed every two hours, for one week.
   3. Refer to "Instructions and Adjustments"
   4. Field verification and demonstration of sequence of operations.

3.11 EXISTING CONTROL DEVICES

A. Notify the Owner's Representative of existing control devices that need to be replaced or repaired that may be noticed in the process of installation of new work

3.12 INTEGRATION WITH EQUIPMENT CONTROL

A. The DDC system shall fully integrate to provide full monitoring and control functions for equipment shown.

3.13 POINT DESCRIPTION AND PROGRAM LIST

A. General:
   1. Points listed are the minimum number of points to be provided. Provide additional points as required to satisfy the sequence and operational requirements.
   2. Provide spare points. After the system has been completed and tested, the following minimum quantity of spare points shall be available for future connection at each DCP:

      a. Binary inputs: 2
      b. Binary outputs: 2
      c. Analog inputs: 1
      d. Analog outputs: 1

   3. Provide proportional-integral-derivative algorithms for all control programs.
   4. Determine, through operation of the system, proportional bands, interval time, integral periods, adjustment rates, and any other input information required to provide stable operation of the control programs.
   5. The following definitions apply to the letter descriptors used in the point lists:

a. RT - Run time of a piece of equipment. This shall be the total operating time since initial start-up of a piece of equipment.
b. T - Indicates the point shall be trendable.
c. A - Indicates the system shall alarm when the point is outside its range, or upon contact closure or opening.
d. CS - Current Sensor

6. All alarms shall be trendable. All equipment start/stops shall be trendable.
7. At a minimum, each sequence and accompanying point list shall be represented by an individual graphic. Each point listed shall appear on the graphic. Where appropriate and approved, multiple sequences and point lists may be combined into a single graphic.

   a. For analog outputs, display on the graphic the percent of full signal (percent open for valves and dampers, percent of speed for variable speed drives, percent open for vortex dampers, etc.).
   b. For analog outputs controlled by analog inputs, provide a probe at the graphic to redefine the proportional, integral, and derivative gains.
   c. Alarm set points and ranges shall be resettable from the graphic. Control set points and ranges shall be resettable from the graphic.
   d. Where average point values are called for in the sequence, the average value shall be displayed on the graphic. In response to a probe on the graphic, the individual sensor values and sensor locations shall be displayed
8. Where dampers operate in conjunction with fan operation, the damper open signal shall precede the fan start signal by 10 to 15 seconds. The damper close signal shall be delayed 10 to 15 seconds after the fan stop signal.

3.14 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
5. Test each point through its full operating range to verify that safety and operating control set points are as required.
6. Test each control loop to verify stable mode of operation and compliance with sequence of operation.
7. Test each system for compliance with sequence of operation.
8. Test software and hardware interlocks.

B. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check temperature instruments and material and length of sensing elements.
5. Check control valves. Verify that they are in correct direction.
6. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

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

3.15 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

END OF SECTION

SECTION 23 0993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Related Sections include the following:

1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

A. BMS: Building Management System.

1.4 AIR HANDLING UNIT (AHU-1)

A. Control Sequence

1. Air handling unit is a variable volume unit which consists of (1) supply fan, (1) hot water coil with control valve, (1) refrigerant coil, (1) mixing box with return air and outside air dampers.

2. The air handling unit shall be controlled during the occupied/unoccupied modes via the Building Management System (BMS), through an owner directed time schedule.

3. Automatic/manual control

The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the “H” position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall in response to BMS control and system safety circuits.

4. Equipment start

In the event that the air handling unit is shut off, upon a call for the equipment to restart the equipment shall be provided with a 15 second starting delay relay.

5. Unoccupied Mode

The “Time of Day” program shall cause the air handling units to go to unoccupied mode settings when called for by the schedule program. In the unoccupied mode the unit shall run continuously and modulate fan speed as described below. The outside air damper shall be closed. The supply air temperature shall be maintain a discharge air temperature of 55 degrees F (adj) in the summer and 70 degrees F (adj) in the winter.

6. Occupied Mode/Normal conditions

The “Time of Day” program shall cause the air handling units to go to occupied mode settings to start and run continuously and controls to be energized. The outside air damper shall open.

The DDC system shall modulate the fan speed with a 4-20 MA signal to variable frequency drive based on duct pressure sensor. As duct pressure decreases, fan speed shall increase. As duct pressure increases, fan speed shall decrease. The static pressure sensor located 2/3 down the ductwork shall maintain the static pressure setpoint as determined by the balancing company.

7. Temperature Economizer Control

The BMS shall perform an enthalpy calculation to determine when it is more energy efficient to use outside air for cooling. The BMS shall continually monitor the return air enthalpy, constantly comparing it to the outdoor air enthalpy. Based on the data and the enthalpy calculation the BMS shall modulate outside air and return air dampers to achieve mixed air temperature setpoint (adj.)

When the outside air enthalpy is greater than the return air enthalpy, the outside air damper shall return to minimum position. When the mixed air temperature falls below setpoint 55 degrees F (adj.) the outside damper shall go to minimum position. If cooling is required, but the return air temperature is lower than the outdoor air temperature, the outdoor air dampers shall go to their minimum position. If the return air temperature is below an operator definable limit, then a warm-up cycle shall be initiated forcing the outside air dampers to their closed position. When return air temperature increases above the limit, plus a definable differential, then the warm-up cycle shall be terminated.

8. Morning Cool-Down Mode

If three hours prior to the occupied mode, the return temperature is greater than 3 degrees F (adj.) above the average occupied mode setpoint, the system shall enter the cool down mode. The BMS system shall mathematically calculate based on the systems heuristics and internal algorithms, the optimum start time for obtaining the desired space temperature setpoint prior to the time of occupancy to accommodate a “cool down” cycle. The BMS shall position the air handling unit control equipment as follows:

- Louver outside air damper = 100% closed
- Louver exhaust damper = 100% closed
- Mixing box return damper = Open
- Mixing box outside air damper = Min position as set at balancing

- Return fan = Modulating
- Supply fan = Modulating
- Hot water valve = Closed
- Refrigerant circuit = Enabled
- VAV boxes = Modulating

The refrigerant circuit shall maintain the discharge air temperature to 55 deg F (adj).

Based on occupied mode "time of day" scheduling the BMS shall place the air-handling unit into the occupied mode.

9. Morning Warm-up Mode

If three hours prior to the occupied mode, the return temperature is 5 degrees F (adj.) lower than the average occupied mode setpoint, the system shall enter the warm-up mode. The BMS system shall mathematically calculate based on the systems heuristics and internal algorithms, the optimum start time for obtaining the desired space temperature setpoint prior to the time of occupancy to accommodate a "warm-up" cycle. The BMS shall position the air handling unit control equipment as follows:

- Louver outside air damper = 100% closed
- Louver exhaust damper = 100% closed
- Mixing box return damper = Open
- Mixing box outside air damper = Min position as set at balancing
- Return fan = Constant Volume- min cfm heating set at balancing
- Supply fan = Constant Volume- min cfm heating set at balancing
- Hot water valve = Modulating
- Refrigerant circuit = Disabled
- VAV boxes = Min heating position

The hot water control valve shall modulate to maintain the discharge air temperature of 70 deg F (adj).

Based on occupied mode "time of day" scheduling the BMS shall place the air-handling unit into the occupied mode.

10. Occupied Mode - Cooling

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Louver exhaust damper = 100% closed
- Mixing box return damper = Modulating
- Mixing box outside air damper = Min position as set at balancing
- Return fan = Modulating
- Supply fan = Modulating
- Hot water valve = Closed
- Refrigerant circuit = Enabled

- VAV boxes = Modulating

The refrigerant circuit shall maintain the discharge air temperature to 55 deg F (adj).

11. Occupied Mode - Heating

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Louver exhaust damper = 100% closed
- Mixing box return damper = Open
- Mixing box outside air damper = Min position as set at balancing
- Return fan = Constant Volume- min cfm heating set at balancing
- Supply fan = Constant Volume- min cfm heating set at balancing
- Hot water valve = Modulating
- Refrigerant circuit = Disabled
- VAV boxes =Min heating position

The hot water control valve shall modulate to maintain the discharge air temperature of 55 deg F (adj).

12. Economizer

When the unit enters into economizer and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Louver exhaust damper = 100% open
- Mixing box return damper = Modulating
- Mixing box outside air damper = Modulating
- Return fan = Modulating
- Supply fan = Modulating
- Hot water valve = Closed
- Refrigerant circuit = Disabled
- VAV boxes = Modulating

B. Air handling unit Components

1. Supply Fan

The supply fan is variable volume

2. Air Monitoring Stations

The air volumetric flow shall be measured by outdoor air flow monitoring stations.

3. Return air damper

A static pressure sensor in mixed air plenum shall continuously modulate the return air damper to maintain set point (adj.) Setpoint to be determined based on unit balancing under full load conditions. As static pressure increases, damper shall open. As static pressure decreases, damper shall close

Under economizer control, damper to modulate to maintain mixed air temperature as described above.

4. Outside air damper

Under normal operation damper to be fixed at minimum ventilation balanced set point. During economizer control, damper to modulate to maintain a mixed air temperature as described above.

5. Hydronic heating coil

Valve to modulate, as identified above, to maintain a discharge air temperature setpoint.

6. Smoke Detection

The air duct smoke detector, upon sensing smoke, shall stop the fans and de-energize controls via hard wire connection to fire alarm system.

7. Associated air cooled outdoor condensing unit

BMS to enable/disable the cooling system as described above. BMS to provide a temperature setpoint to the cooling system controls. The cooling system controls to modulate the compressor as required to maintain setpoint as sensed by a hard wired temperature sensor connected to cooling system controls.

C. Alarms

1. Fan Failure

If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".

2. Filter Maintenance

A differential pressure switch with sensors on upstream and downstream side of filter shall signal the BMS system when the differential pressure is equal to or greater than the setpoint (adj.). The BMS shall initiate an alarm signal at the operator's workstation indicating a clogged filter and requirement for maintenance.

3. Low Limit Thermostat #1

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 40 degrees F (adj.) the supply fan shall be shut down, set heating coils to full heat, fully close the outside air damper, fully open the return air damper, and the BMS

shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.

4. Low Limit Thermostat #2

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 30 degrees F (adj.) the supply fan shall be shut down, set heating coils to full heat, fully close the outside air damper, fully open the return air damper, and the BMS shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.

5. Condensate Pan Level Alarm

A conductivity probe assembly shall be provided in the air handling unit condensate pan to detect the level of condensate in the coil drain pan. In the event that the level of the condensate rises above the probes detection mechanism The BMS shall initiate an alarm signal at the operator's workstation.

6. Discharge air temperature

If the unit discharge air temperature is greater than 15 degrees F (adj) from setpoint the BMS shall initiate an alarm signal at the operator's workstation.

7. Outdoor air and relief air damper position at wall opening

In the event that the unit is commanded to run but the damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's work-station tagged damper failure.

8. ACCU Failure

If status of the outdoor condenser, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The unit shall be identified by its designation and shall be tagged as a "FAN FAILURE". If a failure is initiated by the ACCU contact closure BMS shall initiate an alarm signal at the operator's workstation as described above.

1.5 RELIEF AIR FAN (RAF-1)

A. Control Sequence

1. The return shall be controlled during the occupied/unoccupied modes via the Building Management System (BMS), through an owner directed time schedule

2. Automatic/manual control

The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety

devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall in response to BMS control and system safety circuits

3. As identified above the DDC system shall modulate the return fan speed to maintain return air velocity pressure setpoint during cooling and economizer operations. The return air velocity setpoint shall equal the supply fan air velocity pressure, minus a differential equal to the minimum outside air flow requirements as determined at balancing.

4. Refer to sequencing above for additional information.

B. Alarms

1. Fan Failure

If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".

1.6 TERMINAL VAV BOXES WITH HOT WATER REHEAT

A. Control sequencing

1. The vav boxes shall be controlled during the occupied/unoccupied modes via the Building Management System (BMS), through an owner directed time schedule.

2. Unoccupied Mode

The "Time of Day" program shall cause the VAV boxes to go to unoccupied mode settings when called for by the schedule program. The space temperature settings shall be set to reset to 55 degrees F (asj) winter and 85 degrees F (adj) summer.

3. Occupied Mode/Normal conditions- cooling

The BMS system shall modulate the variable volume damper and reheat coil valve in sequence to achieve the desired space temperature setpoint of 74 degrees F (adj). When the space temperature exceeds the cooling setpoint (adj.), the variable air volume (VAV) damper shall modulate open. As the temperature falls VAV damper modulates to minimum position. Total minimum cfm position of VAV boxes to not be less than the required outside air.

4. Occupied Mode/Normal conditions- heating

After damper reaches minimum position, the space temperature shall drift in a dead-band until reaching the heating control setpoint. As temperature continues to fall below setpoint, damper to go to minimum heating position as set by the balancing contractor to match scheduled value and reheat coil valve shall modulate open. Heating coil control to modulate to maintain the space occupied heating set point of 72 degrees F (adj). If the space setpoint is satisfied the valve shall modulate to maintain a discharge air temperature of 70 degrees F (adj.).

5. Morning Cool-Down Mode

If three hours prior to the occupied mode, the return temperature is greater than 3 degrees F (adj.) above the average occupied mode setpoint, the system shall enter the cool down mode. The BMS system shall mathematically calculate based on the systems heuristics and internal algorithms, the optimum start time for obtaining the desired space temperature setpoint prior to the time of occupancy to accommodate a “cool down” cycle. VAV damper shall modulate open as described above.

6. Morning Warm-up Mode

If three hours prior to the occupied mode, the return temperature is 5 degrees F (adj.) lower than the average occupied mode setpoint, the system shall enter the warm-up mode. The BMS system shall mathematically calculate based on the systems heuristics and internal algorithms, the optimum start time for obtaining the desired space temperature setpoint prior to the time of occupancy to accommodate a “warm-up” cycle. VAV hot water reheat coil control valve shall modulate open as described above until occupied mode space temperature is achieved.

B. Components

1. Air Monitoring Stations

The air volumetric flow shall be measured by supply air flow monitoring station as a monitoring point. Intent is to not control based on airflow measurement.

C. Additional interconnections

1. Provide window contact switch to verify if window is open or closed. If contact is made, window is closed, VAV to operate as described above. If contact is opened, window is open, VAV to completely close.
2. VAV’s associated with the woman’s and men’s toilet rooms are to maintain a constant airflow. Hot water control valve to modulate as described above.

1.7 AIR HANDLING UNIT (AHU-2)

A. Control Sequence

1. Air handling unit is a variable volume unit which consists of (1) supply fan, (1) hot water coil with control valve, (1) refrigerant coil, (1) mixing box with return air and outside air dampers.

2. The air handling unit shall be controlled during the occupied/unoccupied modes via the Building Management System (BMS), through an owner directed time schedule.

3. Automatic/manual control

The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the “H” position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall in response to BMS control and system safety circuits.

4. Unoccupied Mode

The “Time of Day” program shall cause the air handling unit and terminal units to go to unoccupied mode settings when called for by the schedule program. The space temperature settings shall be set to reset to 55 degrees F (adj.) winter and 85 degrees F (adj.) summer. In the unoccupied mode the outside air damper shall be closed. The DDC system shall use space temperature sensors to cycle the air handling unit to prevent the space temperature from falling below or above the setpoint. The outside air damper shall remain closed.

5. Occupied Mode

The room occupancy sensor along with “Time of Day” program shall energize the unit control and switch from unoccupied temperature setting to an occupied setting. The space temperature settings shall be set to reset to 72 degrees F (adj.) winter and 74 degrees F (adj.) summer. The following sequencing shall be maintained.

- Occupancy is not detected- Outside air damper to close and unit to run continuously. VAV boxes to modulate to maintain space temperature.
- Occupancy detected- Outside damper to modulate 100% open. Unit to run continuously.

The DDC system shall modulate the fan speed with a 4-20 MA signal to variable frequency drive based on duct pressure sensor. As duct pressure decreases, fan speed shall increase. As duct pressure increases, fan speed shall decrease. The static pressure sensor located 2/3 down the ductwork shall maintain the static pressure setpoint as determined by the balancing company.

6. Occupied Mode, occupancy detected - Cooling

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Mixing box return damper = Min position as set at balancing
- Mixing box outside air damper = Min position as set at balancing
- Supply fan = Modulating
- Hot water valve = Closed
- Refrigerant circuit = Enabled
- VAV boxes = Modulating

BMS to enable and disable the refrigerant system to maintain the discharge air temperature to 55 deg F (adj). If the discharge air temperature is satisfied refrigerant circuit to be disabled.

7. Occupied Mode, occupancy not detected - Cooling

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% closed

- Mixing box return damper = Min position as set at balancing
- Mixing box outside air damper = Min position as set at balancing
- Supply fan = Modulating
- Hot water valve = Closed
- Refrigerant circuit = Enabled
- VAV boxes = Modulating

BMS to enable and disable the refrigerant system to maintain the discharge air temperature to 55 deg F (adj). If the discharge air temperature is satisfied refrigerant circuit to be disabled.

8. Occupied Mode, occupancy detected - Heating

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Mixing box return damper = Min position as set at balancing
- Mixing box outside air damper = Min position as set at balancing
- Supply fan = Constant Volume- min cfm heating set at balancing
- Hot water valve = Modulating
- Refrigerant circuit = Disabled
- VAV boxes =Min heating position

The hot water control valve shall modulate to maintain the discharge air temperature of 55 deg F (adj).

9. Occupied Mode, occupancy not detected - Heating

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% closed
- Mixing box return damper = Min position as set at balancing
- Mixing box outside air damper = Min position as set at balancing
- Supply fan = Constant Volume- min cfm heating set at balancing
- Hot water valve = Modulating
- Refrigerant circuit = Disabled
- VAV boxes =Min heating position

The hot water control valve shall modulate to maintain the discharge air temperature of 55 deg F (adj).

B. Air handling unit Components

1. Supply Fan

The supply fan is variable volume

2. Air Monitoring Stations

The air volumetric flow shall be measured by outdoor air flow monitoring stations.

3. Return air damper

Under normal operation damper to be fixed at minimum ventilation balanced set point.

4. Outside air damper

Under normal operation damper to be fixed at minimum ventilation balanced set point..

5. Hydronic heating coil

Valve to modulate, as identified above, to maintain a discharge air temperature setpoint.

6. Refrigerant circuit

BMS to enable and disable the refrigerant system to maintain the discharge air temperature setpoint. If the discharge air temperature is satisfied refrigerant circuit to be disabled.

C. Alarms

1. Fan Failure

If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".

2. Filter Maintenance

A differential pressure switch with sensors on upstream and downstream side of filter shall signal the BMS system when the differential pressure is equal to or greater than the setpoint (adj.). The BMS shall initiate an alarm signal at the operator's workstation indicating a clogged filter and requirement for maintenance.

3. Low Limit Thermostat #1

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 40 degrees F (adj.) the supply fan shall be shut down, set heating coils to full heat, fully close the outside air damper, fully open the return air damper, and the BMS shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.

4. Low Limit Thermostat #2

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 30 degrees F (adj.) the supply fan shall be shut down, set heating coils to full heat, fully close the outside air damper, fully open the return air damper, and the BMS

shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.

5. Condensate Pan Level Alarm

A conductivity probe assembly shall be provided in the air handling unit condensate pan to detect the level of condensate in the coil drain pan. In the event that the level of the condensate rises above the probes detection mechanism The BMS shall initiate an alarm signal at the operator's workstation.

6. Discharge air temperature

If the unit discharge air temperature is greater than 15 degrees F (adj) from setpoint the BMS shall initiate an alarm signal at the operator's workstation.

7. Outdoor air damper position at wall opening

In the event that the unit is commanded to run but the outdoor air damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged outdoor air damper failure.

8. ACCU Failure

If status of the outdoor condenser, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The unit shall be identified by its designation and shall be tagged as a "FAN FAILURE". If a failure is initiated by the ACCU contact closure BMS shall initiate an alarm signal at the operator's workstation as described above.

1.8 FAN COIL UNIT (FCU-1)

A. Control Sequence

1. Air handling unit is a variable volume unit which consists of (1) supply fan, (1) hot water coil with control valve, (1) refrigerant coil, (1) mixing box.

2. The air handling unit shall be controlled during the occupied/unoccupied modes via the Building Management System (BMS), through an owner directed time schedule.

3. Automatic/manual control

The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall in response to BMS control and system safety circuits.

4. Unoccupied Mode

The “Time of Day” program shall cause the unit to go to unoccupied mode settings when called for by the schedule program. The space temperature settings shall be set to reset to 55 degrees F (adj.) winter and 85 degrees F (adj.) summer. In the unoccupied mode the outside air damper shall be closed. The DDC system shall use space temperature sensors to cycle the air handling unit to prevent the space temperature from falling below or above the setpoint. The outside air damper shall remain closed.

5. Occupied Mode

The room occupancy sensor along with “Time of Day” program shall energize the unit control and switch from unoccupied temperature setting to an occupied setting. The space temperature settings shall be set to reset to 72 degrees F (adj.) winter and 74 degrees F (adj.) summer. The following sequencing shall be maintained:

- Occupancy is not detected- Outside air damper to close and DDC system shall use the space temperature sensor to cycle the air handling unit to prevent the space temperature from falling above or below setpoint.
- Occupancy detected- Outside damper to modulate 100% open. Unit to run continuously.

6. Occupied Mode, occupancy detected - Cooling

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Supply fan = Constant
- Hot water valve = Closed
- Refrigerant circuit = Enabled

BMS to enable and disable the refrigerant system to maintain the space temperature. If the space temperature is satisfied refrigerant circuit to be disabled.

7. Occupied Mode, occupancy not detected - Cooling

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% closed
- Supply fan = Energized/de-energized based on space temp
- Hot water valve = Closed
- Refrigerant circuit = Enabled

BMS to enable and disable the refrigerant system to maintain the space temperature. If the space temperature is satisfied refrigerant circuit to be disabled

8. Occupied Mode, occupancy detected - Heating

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% open
- Supply fan = Constant
- Hot water valve = Modulating
- Refrigerant circuit = Disabled

The hot water control valve shall modulate to maintain the space temperature setpoint. If the space setpoint is satisfied the valve shall modulate to maintain a discharge air temperature of 70 degrees F (adj.).

9. Occupied Mode, occupancy not detected - Heating

When the unit enters the occupied mode and the BMS shall position the Air Handler control equipment as follows:

- Louver outside air damper = 100% closed
- Supply fan = Energized/de-energized based on space occupancy
- Hot water valve = Modulating
- Refrigerant circuit = Disabled

The hot water control valve shall modulate to maintain the space temperature setpoint.

B. Air handling unit Components

1. Supply Fan

The supply fan is variable volume

2. Air Monitoring Stations

The air volumetric flow shall be measured by outdoor air flow monitoring stations.

3. Hydronic heating coil

Valve to modulate, as identified above, to maintain a discharge air temperature setpoint.

4. Refrigerant circuit

BMS to enable and disable the refrigerant system to maintain the space temperature. If the space temperature is satisfied refrigerant circuit to be disabled.

C. Alarms

1. Fan Failure

If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the op-

erator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".

2. Filter Maintenance

A differential pressure switch with sensors on upstream and downstream side of filter shall signal the BMS system when the differential pressure is equal to or greater than the setpoint (adj.). The BMS shall initiate an alarm signal at the operator's workstation indicating a clogged filter and requirement for maintenance.

3. Low Limit Thermostat #1

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 40 degrees F (adj.) the supply fan shall be shut down, set heating coils to full heat, fully close the outside air damper, fully open the return air damper, and the BMS shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.

4. Low Limit Thermostat #2

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 30 degrees F (adj.) the supply fan shall be shut down, set heating coils to full heat, fully close the outside air damper, fully open the return air damper, and the BMS shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.

5. Condensate Pan Level Alarm

A conductivity probe assembly shall be provided in the air handling unit condensate pan to detect the level of condensate in the coil drain pan. In the event that the level of the condensate rises above the probes detection mechanism The BMS shall initiate an alarm signal at the operator's workstation.

6. Discharge air temperature

If the unit discharge air temperature is greater than 15 degrees F (adj) from setpoint the BMS shall initiate an alarm signal at the operator's workstation.

7. Outdoor air damper position at wall opening

In the event that the unit is commanded to run but the outdoor air damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged outdoor air damper failure.

8. ACCU Failure

If status of the outdoor condenser, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The unit shall be identified by its designation and shall be tagged as a "FAN FAILURE". If a failure is initiated by the ACCU contact

closure BMS shall initiate an alarm signal at the operator's workstation as described above

1.9 HEAT RECOVERY UNITS (HRU-1 & 2)

A. Control Sequence

1. Air handling unit is a variable volume unit which consists of (1) supply fan, (1) return fan, (1) gas burner, (1) plate and frame heat exchanger, face and bypass dampers, outside air intake dampers, and exhaust air dampers.

   Heat recovery units to operate continuously. The outside air damper and exhaust air damper shall open.

2. Automatic/manual control

   The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall in response to BMS control and system safety circuits.

3. Temperature Economizer Control

   The BMS shall perform an enthalpy calculation to determine when it is more energy efficient to use outside air for cooling. The BMS shall continually monitor the return air enthalpy, constantly comparing it to the outdoor air enthalpy. Based on the data and the enthalpy calculation the BMS shall modulate heat exchanger bypass damper and face damper to achieve mixed air temperature setpoint (adj.) when cooling is required. Note, bypass damper is not sized for full bypass, intent is to provide as much free cooling as possible when cooling is required and outdoor conditions allow for free cooling.

   When the outside air enthalpy is greater than the return air enthalpy, the bypass air damper shall close. When the mixed air temperature falls below setpoint 55 degrees F (adj.) the bypass damper shall close. If cooling is required, but the return air temperature is lower than the outdoor air temperature, the bypass air dampers shall close.

4. Typical Operation

   When the unit enters the occupied mode and the BMS shall position the heat recovery control equipment as follows:

   - Outside air damper = Open
   - Heat exchanger bypass damper = 100% closed
   - Exhaust air damper = Open
   - Return fan = Constant Volume
   - Supply fan = Constant Volume

   The gas control valve shall modulate to maintain the discharge air temperature of 70 deg F (adj).

5. Economizer

When cooling is required and economizer cooling is available the BMS shall position the heat recovery control equipment as follows:

- Outside air damper = Open
- Heat exchanger bypass damper = Modulating
- Exhaust air damper = Open
- Return fan = Constant Volume
- Supply fan = Constant Volume

B. Air handling unit Components

1. Supply Fan

The supply fan is constant volume

2. Air Monitoring Stations

The air volumetric flow shall be measured by piezometers mounted to the fan.

3. Exhaust air damper

Damper to be open or closed based on occupancy schedule.

4. Outside air damper

Damper to be open or closed based on occupancy schedule.

5. Gas burner

Burner controls to maintain a discharge air temperature setpoint of 70 deg F (adj). BMS to provide output to the burner controls for setpoint adjustment. Burner controls to receive discharge air temperature input from the BMS.

6. Smoke Detection

The air duct smoke detector, upon sensing smoke, shall stop the fans and de-energize controls via hard wire connection to fire alarm system.

7. Heat exchanger bypass damper

The heat exchanger shall be in by-pass mode until both the exhaust fan and supply fan are proved operational.

During normal operation damper to remain closed. During economizer control, the face and bypass damper to modulate to maintain a mixed air temperature as described above.

Winter mode: The winter mode shall be activated when the outside air temperature is below the heat exchanger supply setpoint. In this mode the face and bypass damper shall be modulated to maintain the heat exchanger supply setpoint

Defrost mode: The frost mode shall be activated when the exhaust air drops below 32 deg F (adj). When this occurs the heat exchanger by-pass damper is to cycle open and the face damper is to cycle closed. When the exhaust air temperature is 10 def F (adj) above the exhaust air set point the heat exchanger will resume normal operation. This mode shall over-ride the winter mode.

C. Alarms

1. Fan Failure

If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".

2. Filter Maintenance

A differential pressure switch with sensors on upstream and downstream side of filter shall signal the BMS system when the differential pressure is equal to or greater than the setpoint (adj.). The BMS shall initiate an alarm signal at the operator's workstation indicating a clogged filter and requirement for maintenance.

3. Low Limit Thermostat #1

The low limit thermostat shall monitor the discharge air temperature. When temperature drops below 40 degrees F (adj.) the supply fan shall be shut down the return fan shall continue to operate, fully close the outside air damper, and the BMS shall initiate an alarm signal at the operator's workstation. The low limit thermostat shall be manually reset before system can resume normal operation.
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4. Discharge air temperature

If the unit discharge air temperature is greater than 15 degrees F (adj) from setpoint the BMS shall initiate an alarm signal at the operator's workstation.

5. Outdoor air and exhaust air damper position

In the event that the unit is commanded to run but the damper end switch is not made the associated fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged damper failure.

6. Gas burner alarm

In the event that the BMS receives a signal from the gas burner alarm BMS shall initiate an alarm signal at the operator's workstation tagged HRU-x burner failure

7. HRU-2 fueling exhaust duct pressure sensor

BMS to constantly monitor the pressure difference between the outdoors and the main exhaust duct serving the fueling area. In the event that the pressure difference is greater than -.1”WC BMS to initiate an alarm signal at the operator’s workstation tagged “fueling area airflow not verified” and shall send a signal to the fueling system shunt trip breaker to disable all dispensing within the building.

1.10 Reheat coil (RHC-1)

A. Control sequence

1. The reheat shall be controlled during the occupied/unoccupied modes via the Building Management System (BMS), through an owner directed time schedule

2. Unoccupied mode

BMS to modulate the reheat coil control valve to maintain a night setback temperature setpoint of 55 degrees F (adj).

3. Morning Warm-up Mode

If three hours prior to the occupied mode, the average core garage space temperature is 5 degrees F (adj.) lower than the average occupied mode setpoint, the system shall enter the warm-up mode. The BMS system shall mathematically calculate based on the systems heuristics and internal algorithms, the optimum start time for obtaining the desired space temperature setpoint prior to the time of occupancy to accommodate a “warm-up” cycle.

During morning warm-up operation, when the heat recovery supply fan is running and hot water is available, the BMS shall control the control valve to 100 % open. Once the average garage core temperature reaches setpoint of 70 deg F (adj) the warm-up cycle shall be terminated.

4. Occupied mode

During occupied periods of operation, when the heat recovery supply fan is running, and hot water is available the BMS shall modulate the control valve to maintain the average core occupied heating set point of 72 degrees F (adj), BMS to average the temperature reading of the two core temperature sensors. If the space setpoint is satisfied the valve shall modulate closed.

1.11 HOT WATER UNIT HEATERS AND CABINET UNIT HEATERS

A. Control sequence

1. The unit heater shall be energized and de-energized by the BMS. Upon a call for heat, BMS shall energize then fan and modulate the control valve to maintain a occupied space temperature setpoint of 72 degrees F (adj) as sensed by the space temperature sensor. During the unoccupied winter mode of operation, the unit shall be cycled to maintain a night setback temperature setpoint of 55 degrees F (adj.).

2. The unit shall be de-energized during the summer modes of operation.

1.12 HEATING SYSTEM

A. The following components are associated with the hot water heating system:.
   1. Main circulating pumps (HWP-1&2)
   2. Boilers (B-1,2,&3)
   3. Boiler pumps (HWP-3,4,&5)

B. The hot water system shall be enable when either of the following conditions exist
   1. The outdoor air temperature is below 60 deg F (adj).

C. When the hot water system is enable the BMS shall control the equipment as follows:
   1. Main circulating pumps = Energized
   2. Boilers = Enabled
   3. Boiler pumps = Enabled

D. Main circulating pumps
   1. Pumps are variable volume pumps.
   2. The pumps are variable volume pumps and shall modulate to maintain a differential pressure between the hot water supply and return (adj.)
   3. The BMS shall start one pump when the hot water system is enabled
   4. Both pumps shall operate in a lead/lag configuration. The operator shall be able to select either pump to lead via a software switch. Upon a start command a timer shall be initiate, if pump status is not detected within 15 seconds the lag pump shall start, the current lead pump shall be commanded off and an alarm shall sent to the operator's workstation. Both pumps shall alternate and operate as the lead pump every 168 hours (adj.) total runtime.

   5. Automatic/Manual Control

      The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall run continuously and operate in response to BMS control and system safety circuits

   6. Alarm- Pump Failure
      a. If status of the pumps, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The pump shall be identified by its designation and shall be tagged as a "PUMP FAILURE"

E. Boiler (B-1&2)
   1. Boilers to be controlled by boiler management system. Refer to division 23 section "condensing boilers".
   2. BMS to provide loop temperature setpoint, system monitoring, and boiler control enable/disable signal.
   3. BMS shall not enable boilers until operation of main circulating pumps has been verified.
   4. Boiler loop supply setpoint: 180 deg F (adj).
   5. BMS to have the ability to identify boiler alarms.
   6. BMS to generate an alarm when the boiler emergency shut-off is activated. BMS to disable all heat operations. Provide required interconnections to boiler controller.
   7. Hot water loop alarm

a. Low limit hot water return temperature- 55 deg F (adj.)
b. Low limit hot water supply temperature- 130 deg F (adj.)
c. High limit hot water supply temperature- 210 deg F (adj.)

F. Boiler pumps
1. Pumps are constant volume pumps
2. Pumps to be controlled by boiler management system. Refer to division 23 section "condensing boilers".
3. Pumps are to be energized when the associated boiler is energized by the boiler management system
4. BMS to monitor pump operation.
5. Automatic/Manual Control

The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall run continuously and operate in response to BMS control and system safety circuits

6. Alarm- Pump Failure
a. If status of the pumps, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The pump shall be identified by its designation and shall be tagged as a "PUMP FAILURE"

1.13 EXHAUST FAN (EF-1)

A. The fan shall be controlled during the occupied/unoccupied modes by the BMS, through an owner directed time schedule .

B. Unoccupied Mode
1. The "Time of Day" program shall cause the fan to go to unoccupied mode settings when called for by the schedule program and the fan shall be disabled.

C. Occupied Mode
1. The "Time of Day" program shall cause the fan to go to occupied mode settings to start and run continuously and controls to be energized

D. Alarms
1. Fan Failure
a. If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".
2. Exhaust air damper position
a. In the event that the unit is commanded to run but the exhaust air damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged exhaust air damper failure

1.14 EXHAUST FAN (EF-2 & 3)

A. The fan shall be enabled to run continuously.

B. Alarms
1. Fan Failure
a. If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".
2. Exhaust air damper position
a. In the event that the unit is commanded to run but the exhaust air damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged exhaust air damper failure.

1.15 EXHAUST FAN (EF-4 & 8)

A. System sequence
1. Exhaust fan to operate continuously at minimum airflow rate. Fan to operate at high level upon detection of gas. Refer to gas detection system below.

B. Alarms
1. Fan Failure
a. If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".
2. Exhaust air damper position
a. In the event that the unit is commanded to run but the exhaust air damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged exhaust air damper failure

1.16 EXHAUST FAN (EF-5,6,7,9,10,11,&12)

A. System sequence
1. The fan shall be energized by the gas detection system. BMS control points for manual activation only.
2. Exhaust fan to be energized and operate at on high upon detection of gas. Refer to gas detection system below.

B. Alarms
1. Fan Failure
a. If status of a fan, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The fan shall be identified by its designation and shall be tagged as a "FAN FAILURE".
2. Exhaust air damper position
a. In the event that the unit is commanded to run but the exhaust air damper end switch is not made the fan shall be disabled and the BMS shall initiate an alarm signal at the operator's workstation tagged exhaust air damper failure

1.17 GAS DETECTION

A. System sequence

1. Gas detection system to initiate a low level alarm A when the level of gas reaches the following concentrations.
   a. Carbon Monoxide- 25 ppm
   b. Nitrogen dioxide- .7 ppm
   c. Methane- 25% LEL
2. Upon detection of a low level alarm A the following sequence shall be initiated by the gas detection control panel independent of BMS.
   a. Associated exhaust fans wall louver damper to be opened
   b. Associated exhaust fans variable frequency drive to be energize and fan to operate at high speed.
   c. High bay duct dampers to be opened- EF-4 and 8 only
   d. Associated garage doors to open.
   e. Send signal to BMS. BMS shall initiate an alarm signal at the operators workstation tagged high gas concentration detected.

3. Gas detection system to provide stand alone control. BMS to monitor.
4. If the gas concentration continues to rise gas detection system to initiate alarm B. Alarm B to be initiated when the level of gas reaches to following concentrations
   a. Carbon Monoxide- 200 ppm
   b. Nitrogen dioxide- 2 ppm
   c. Methane- 50% LEL
5. Upon detection of a Alarm B condition the following sequence shall be initiated
   a. Continue operation as described under alarm condition A
   b. Energize associated horn and strobe
   c. Notify BMS of increased level of gas detected
6. If the gas concentration continues to rise gas detection system to initiate alarm C. Alarm C to be initiated when the level of gas reaches to following concentrations
   a. Carbon Monoxide- 225 ppm
   b. Nitrogen dioxide- 9 ppm
   c. Methane- 90% LEL
7. Upon detection of a Alarm C condition the following sequence shall be initiated
   a. Continue operation as described under alarm condition A and B
   b. Notify BMS of increased level of gas detected
   c. Send alarm to fire alarm panel to notify fire department.

1.18 FIN TUBE RADIATION

A. System sequence

1. The fin tube radiation shall be controlled during the occupied/unoccupied modes via the BMS, through an owner directed time schedule.

2. During the occupied mode and a call for heat the fin tube radiation valve shall open to maintain the space temperature setpoint of 72 degrees F (adj.) as sensed by the space temperature sensor. During unoccupied mode the space setpoint shall be setback to 65 deg F (adj)

3. If the DDC system detects a space sensor failure, an alarm shall be sent to the operator’s workstation

PRODUCTS *Not Used*

PART 2 - EXECUTION *Not Used*

END OF SECTION

SECTION 23 2113

HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Condensate-drain piping.
3. Makeup-water piping
4. Blowdown-drain piping.
5. Air-vent piping.
6. Safety-valve-inlet and -outlet piping

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.
2. Division 23 Section "General-Duty valves."
3. Division 23 Section "HVAC hydronic piping specialties."

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and operating temperature:

1. Hot-Water Heating Piping: 150 psig at 200 deg F.
2. Condensate-Drain Piping: 150 deg F.
3. Make-up water piping: 150 psig at 150 deg F
4. Blowdown-drain piping: 200 deg F
5. Air-vent piping: 200 deg F
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping
   2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   3. Air control devices.

B. Provide piping schedule indicating type of intended installation and installation location. Refer to piping schedule below.

C. Shop/Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate duct and pipe layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items and trades involved: (Submit 3 hard copies of all documents to Architect for Review and Approval):

   1. Duct and piping installation in all spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct and piping layout.
   2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   3. Fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides.
   4. Detail location of anchors, alignment guides, and expansion joints and loops.
   5. Factory- and shop-fabricated ducts and fittings.
   6. Duct layout indicating sizes, configuration, liner material, static-pressure class, and service.
   7. Piping layout indicating sizes, configuration, and service.
   8. Elevation of top of ducts and pipes.
   9. Dimensions of main duct runs from building grid lines.
   10. Duct and pipe fittings.
   11. Reinforcement and spacing.
   12. Suspended ceiling components.
   13. Structural members to which duct and piping will be attached.
   14. Size and location of initial access modules for acoustical tile.
   15. Penetrations of smoke barriers and fire-rated construction.
   16. Room walk paths and equipment access
   17. Items penetrating finished ceiling including the following:

      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Access panels.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.7 QUALITY ASSURANCE

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

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

D. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

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

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

C. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

D. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

E. Grooved Mechanical-Joint Fittings and Couplings:

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

    a. Victaulic Company
    b. Anvil International, Inc.
    c. Central Sprinkler Company; a division of Tyco Fire & Building Products.
    d. National Fittings, Inc.
    e. S. P. Fittings; a division of Star Pipe Products.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron;; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
    a) Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9.
        1. 2” through 8”: “Installation Ready” stab-on design, for direct ‘stab’ installation onto grooved end pipe without prior field disassembly and no loose parts. Gasket shall be Grade “EHP” EPDM suitable for hot water up to 250 deg F.

F. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

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

E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 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 Flanges:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
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.

C. Dielectric-Flange Insulating Kits:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
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.

D. Dielectric Nipples:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:

2. Description:

a. Standard: IAPMO PS 66
b. Electroplated steel nipple. complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller**,** shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be one of the following:

1. Schedule 40 steel pipe, wrought-steel flanged fittings and joints

2. Schedule 40 steel pipe, welded fittings and joints

3. Schedule 40 steel pipe, grooved mechanical joints couplings and fittings, and grooved mechanical joints. Provide rigid couplings.

C. Condensate-Drain piping installed aboveground shall be one of the following:
1. Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints

D. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed

F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 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. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

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

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.3 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 nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.

2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

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

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

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe

wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections. Provide reducer at unit prior to final connection.

B. Install control valves in accessible locations close to connected equipment

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
    a. The entire closed loop system shall be cleaned to remove cutting oils, scale deposits, oxides and other fouling as has determined by the water treatment provider. A water meter shall be installed on the supply line as the system is being filled with water so that an accurate system volume can be determined. A non-acid solution of dispersants such as M.I.S of America, Inc. formula 6200NAC or approved equal, shall be added at a rate of one gallon to 500 gallons of system water. This solution shall be circulated for a minimum of 8 hours. This solution shall be tested by a water treatment consultant to insure the proper dispersant level is being maintained. After the solution has been circulated for a minimum of 8 hours the entire system shall be drained and flushed. A second analysis of the flush water shall be made to insure all of the cleaner is removed and that the system is clean.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, but not less than 100 psi for duration of 60 min. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Verify all air has been removed from the system and continuous water flow from each air vent. This includes all equipment associated with the loop that may have been affected by the work performed.
6. Set temperature controls so all coils are calling for full flow.
7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
8. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 2116

HYDRONIC 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 special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Condensate-drain piping.
3. Makeup-water piping
4. Blowdown-drain piping.
5. Air-vent piping.
6. Safety-valve-inlet and -outlet piping

B. Related sections

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.
2. Division 23 Section "General-Duty valves."
3. Division 23 Section "HVAC hydronic piping specialties."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Hydronic specialties.

B. Provide valve and hydronic specialties schedule indicating type of intended installation and installation location. Refer to schedule below.

C. Shop/Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼” =1’-0” scale, double lined. Drawings shall indicate duct and pipe layout and elevation, and all equipment with manufacturers’ recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items and trades involved: (Submit 3 hard copies of all documents to Architect for Review and Approval):

1. Duct and piping installation in all spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct and piping layout.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides.
4. Detail location of anchors, alignment guides, and expansion joints and loops.
5. Factory- and shop-fabricated ducts and fittings.
6. Duct layout indicating sizes, configuration, liner material, static-pressure class, and service.
7. Piping layout indicating sizes, configuration, and service.
8. Elevation of top of ducts and pipes.
9. Dimensions of main duct runs from building grid lines.
10. Duct and pipe fittings.
11. Reinforcement and spacing.
12. Suspended ceiling components.
13. Structural members to which duct and piping will be attached.
14. Size and location of initial access modules for acoustical tile.
15. Penetrations of smoke barriers and fire-rated construction.
16. Room walk paths and equipment access
17. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
18. Access panels.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and operating temperature:

1. Hot-Water Heating Piping: 150 psig at 200 deg F.
2. Condensate-Drain Piping: 150 deg F.
3. Make-up water piping: 150 psig at 150 deg F
4. Blowdown-drain piping: 200 deg F
5. Air-vent piping: 200 deg F
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Check, and Ball valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping.

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC.

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.

4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

E. Automatic Flow-Control Balancing Valves:

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

   a. Flow Design Inc.
   b. Griswold Controls.
   c. Nexus Valve, Inc.

2. Description: Balancing valve to consist of a spring loaded cartridge that dynamically absorbs pressure fluctuations resulting from changing flow conditions due to varying heating/cooling loads. These fluctuations in pressure do not change the flow through the valve. Flow is to be controlled within a +/- 5% of the design flow. Additional balancing is not required.
3. Body: Brass or ferrous metal.
4. Piston and Spring Assembly: 304 Stainless steel, tamper proof, self cleaning, and removable.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.
10. Body tapings: ¼” NPT with P/T test valves

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.

3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

C. Diaphragm Type Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Taco, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
2. Shell: Fabricated steel designed and constructed per ASME Section VIII, Div 1
3. Diaphragm- Heavy Duty Butyl
4. Working pressure- 120 psig
5. Operating temperature- 240 deg F
6. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
7. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
8. Provide with stand and California sight glass

D. Air and dirt Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Taco, Inc.
   b. Armstrong Pumps, Inc.
   c. Spirotherm
2. Air and dirt removal device shall be constructed of carbon steel. It shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 270°F. Manufacturer shall be holder of ASME U stamp.
3. Provide with flanged system connections as standard. Inlet and outlet connections to be inline with piping system. Both inlet and outlet to be in the same horizontal and vertical planes
4. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. The air vent shall be able to be closed to allow flushing and purging of dirt via side port without dirt passing through vent on initial system fill
5. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator
6. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. The valve and all openings shall be 2”.
7. The air and dirt removal device shall remove air down to 18 microns and shall remove dirt/debris down to 35 microns. The unit shall be 100% efficient at removing dirt down to 90 microns in 100 passes or less.
8. Provide third party independent test data certifying that the unit performs to the above standards.
9. Provide 304 stainless steel coalescence pall ring basket and cage or equivalent technology and performance constructed of stainless steel to achieve optimal separation of air and dirt with minimal pressure drop.
10. Provide base ring stand

11. The unit shall be manufactured with a removable cover to facilitate removal, inspection, and cleaning of the pall ring basket. The entire pall ring basket shall be constructed of stainless steel. For safety and ease of service the unit shall be accessed from the top and the pall ring basket shall be accessed as one complete assembly housed in a stainless steel cage.
12. Provide units in sizes for full-system flow capacity
13. Media- Refer to drawings

2.4 HYDRONIC PIPING SPECIALTIES

A. 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.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install automatic flow control balancing valves at each branch connection to return main.

C. Install automatic flow control balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

B. Install piping to expansion tank with a 2 percent upward slope toward tank.

C. Install air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

E. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2

END OF SECTION

SECTION 23 2123

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following categories of hydronic pumps for hydronic systems:
   1. End-suction pumps.
   2. Close-coupled, in-line centrifugal pumps

B. Related Sections:
   1. Division 23 Section 230500 " Motors and Variable Frequency Drives”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves. Provide wiring diagrams.

1.4 INFORMATION SUBMITTALS

A. Field quality-control reports.

B. Startup service reports.

C. Warranty: Sample of special warranty

1.5 CLOSEOUT SUBMITTALS

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

B. Include vendor contact information for service and warranty.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: Two sets of mechanical seal(s) for each pump.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be fully tested and documented to operate as a complete system.

E. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

F. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

1.10 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Parts: Period of one year from substantial completion, to be free from defects in material and workmanship. Any units or parts which prove defective during the warranty period will be replaced with OEM parts and transportation prepaid.

B. For Labor: One year(s) from date of Substantial Completion

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve. Motors shall be inverter duty rated.

C. Motors Indicated to Be Energy Efficient: Premium efficiency with minimum efficiency as indicated according to NEMA M6 and IEEE 112, Test Method B. Include motors with higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B, if efficiency is not indicated.

2.2 IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. TACO Incorporated.
   2. Armstrong Pumps Inc.
   3. Buffalo Pumps, Inc

B. The pumps shall be single stage horizontal in-line design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.

C. Pump shall be constructed of ASTM A48 class 30 cast iron. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections.

D. All casings shall be flanged connections.

E. The impeller shall be ASTM C87500 or C89833 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted with a holding taper and left handed 431 series stainless steel bolt. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.

F. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable copper nickel

90-10 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.

G. The pump shall be fitted with a single mechanical seal, with EPT elastomers and silicon carbide faces suitable for glycol and rated up to 250ºF. The pump shall be coupled to a NEMA 56C face motor with threaded on shaft extension.

H. Motor: Premium efficiency inverter duty motor.

1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23050 "Motors and variable frequency drives."

   a. Enclosure: Open, dripproof.
   b. Enclosure Materials: Squirrel cage induation type.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 125-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; full length stainless steel straightening vanes; with fine mesh start up filter to be removed after initial start-up. Provide removable stainless steel final filter; Outlet flow stabilizing guide vanes; and drain plug.

B. Triple-Duty Valve:
1. Incorporate the following three functions: tight shut-off, spring-closure type silent non-slam check, and efficient throttling.
2. The body shall have (2) ¼” NPT connections on each side of the valve seat.
3. Two connections to have brass pressure and temperature metering ports, with EDPM check valves and gasket caps.
4. Two other connections to be supplied with drain plugs.
5. Metering ports are to be interchangeable with drain ports to allow for measurement flexability when installed in tight locations.
6. The valve disc shall be bronze plug and disc type with EPDM seat to ensure tight shut-off and silent check operation.
7. Valve body shall be cast iron with ANSI-125 flanged ports.

2.4 VARIABLE FREQUENCY DRIVES

A. Refer to section 230500 “motors and variable frequency drives” for required drive specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.

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

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

3.2 PUMP INSTALLATION

A. Install pumps according to manufacturer's written instructions.

1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so piping is not supported by pumps.

D. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers or per manufacturers written instructions.

E. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.3 ALIGNMENT

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

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. Comply with pump and coupling manufacturers' written instructions.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install isolation valves that are the same size as piping connected to pumps.

D. Install suction diffuser and shutoff valve on suction side of base-mounted pumps.

E. Install triple-duty valve on discharge side of base-mounted pumps.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gages on pump suction, discharge, and at triple-duty valve. Install at integral pressure-gage tappings where provided.

H. Install temperature and pressure-gage connector plugs in suction and discharge piping around each pump.

I. Electrical power and control wiring and connections are specified in Division 26 Sections.

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. 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.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly..

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Provide operation and maintenance manuals.
3. Schedule training with Owner, through Owner’s representative, with at least seven days' advance notice.

END OF SECTION

SECTION 23 2300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
1. Service valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot

C. Delegated-Design Submittal: Provide refrigerant size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment. Provide analysis and data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements based on equipment capacities and equipment characteristics.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

C. Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, ductwork layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items involved: (Submit 3 hard copies of all documents to Architect for Review):

1. Refrigerant piping installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to refrigerant pipe layout.
2. Suspended ceiling components.
3. Structural members to which refrigerant pipe will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: Hard Copper, ANSI H23.5Type L ACR, and ASTM B 88 Type L ACR , in accordance with ASTMB280.

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

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

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. Operator: Rising stem and hand wheel or quarter turn lever
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

2.3 REFRIGERANTS

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Suction Lines: Hard Copper, Type ACR, drawn -temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines: Hard Copper, Type ACR, drawn- temper tubing and wrought-copper fittings with brazed joints.

C. Line sets are not acceptable.

D. Safety-Relief-Valve Discharge Piping: Hard Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless isolation valves at connection to equipment.

3.3 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 Shop Drawings and Delegated-Design.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles and parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

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

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Slope refrigerant piping per manufacturers written instructions or as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

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

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

O. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch .
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch .
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch .
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch .
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch .

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high-, low-pressure, and hot gas reheat side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Pressure Test: Test refrigerant piping using dry, oil-free nitrogen, and prove tight at 300psi on the high side, 300 psi on the hot gas reheat side, and 150 psi on the low side. Maintain pressure for 2 hours with no leakage or reduction in pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with by brushing a small amount of soap and glycerin solution over joints and electronic leak detector.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
    e. Include Test and Inspection certificate in Operation and Maintenance submittal. Certificate to give the name of the refrigerant and the field test pressure applied to the high side and the low side of the system. The certification of test shall be signed by the installer and shall be made part of the public record.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuation: Using high vacuum pump and certified micron gage, reduce absolute pressure on both sides of system simultaneously to 500 microns and 500 microns. After reaching this point charge system with refrigerant until pressure of 0psi is obtained. Repeat evacuation procedure for 2 more cycles, totaling three evacuation-charging cycles. On final evacuation, secure pump and maintain 500 microns and 500 microns for 12 hours before charging with required final refrigerant. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

B. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 2500

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water-treatment systems for the following:

1. Hot water piping (closed-loop system)

1.3 PERFORMANCE REQUIREMENTS

A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of connected equipment without posing a hazard to operating personnel or the environment. The water treatment consultant shall coordinated with equipment manufacturers to determine the required pH level and chemical treatment required to accommodate the connected equipment water treatment requirements.

B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

1. Closed System: Maintain system essentially free of scale, corrosion, and fouling to sustain the water characteristics recommended by the connected equipment manufacture.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:

1. Bypass filter feeder
2. Test equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports

B. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site prior and post system drainage

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pumps, feeders, filters, system controls, and accessories to include in maintenance manuals.

B. Include vendor contact information for service and warranty.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Provide all equipment and chemicals through an experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project. The installer shall by a member in good standing of the Association of Water Technologies and the water program shall be supervised by a Certified Water Technologist. The representative shall reside within 100 miles of the job site and maintain a laboratory for water testing.

1.8 MAINTENANCE AND SERVICE

A. Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths. Services and chemicals shall be provided for a period of two years from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

B. Service

The water treatment consultant shall perform monthly on site tests of the system for two years. These tests shall include, but not be limited to, the following:

PH
Hardness
T- Alkalinity
Inhibitor Level
% Glycol
Freeze point
Oxides matching the metallurgy of the system

C. Provide a one-year supply of 10 micron filter bags associated with bag filter feeder.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. HVAC Water-Treatment Products:

a. M.I.S of America, Inc.

2.2 HOT WATER (CLOSED-LOOP SYSTEM)

A. System cleaning

1. The entire closed loop system shall be cleaned to remove cutting oils, scale deposits, oxides and other fouling as has determined by the water treatment consultant. A water meter shall be installed on the supply line as the system is being filled with water so that an accurate system volume can be determined. A non-acid solution of dispersants M.I.S of America, Inc. formula 6200NAC or approved equal shall be added at a rate of one gallon to 500 gallons of system water. This solution shall be circulated for a minimum of 8 hours. This solution shall be tested by the water treatment consultant to insure the proper dispersant level is being maintained. After the solution has been circulated for a minimum of 8 hours the entire system shall be drained and flushed. A second analysis of the flush water shall be made to insure all of the cleaner is removed and that the system is clean.

B. Equipment

1. Bypass Filter Style Feeder
   a. Capacity- 7 gallon
   b. Rated for high flow applications
   c. Construction- 10 gauge carbon steel
   d. Operating pressure- 200 psi at 200 deg F
   e. Adjustable legs
   f. Perforated stainless steel basket
   g. Finish- Gray epoxy
   h. Provide two sets of 20 and 5 micron filter bags
   i. Provide a one-year supply of 10 micron filter bags

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. The water treatment supplier is required to perform an initial water supply analysis to determine the specific program and the quantities of chemical to be supplied to match existing conditions. A copy of the analysis shall be submitted to the engineer.

3.2 INSTALLATION

A. Installation by the contractor with supervision of the supplier.

1. Installing the contractor to coordinate with the chemical equipment and product supplier.
2. Install equipment plumb and level.
3. Add cleaning chemicals as recommended by the supplier.

B. Test system mixture and provide report to engineer for approval

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings and specialties.

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

3.4 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.
1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Test system mixture
5. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation

B. Test chemical feed piping as follows:

1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
6. Prepare test reports, including required corrective action.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water- treatment systems and equipment.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

B. Review manufacturer's safety data sheets for handling of chemicals.

C. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.

D. Schedule at least 2 hours training with Owner, with at least seven days' advance notice.

END OF SECTION

SECTION 23 3113

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" Volume Four and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Structural Performance: Hangers and supports for ductwork shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Lined ductwork
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Factory- and shop-fabricated ducts and fittings.
4. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
5. Ceiling devices and associated airflow rates.
6. Elevation of top of ducts.
7. Dimensions of main duct runs from building grid lines.
8. Fittings.
9. Reinforcement and spacing.
10. Seam and joint construction.
11. Penetrations through fire-rated and other partitions.
12. Equipment installation based on equipment being used on Project.
13. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
14. Hangers and supports, including methods for duct and building attachment and vibration isolation.
15. Sheet metal thicknesses

B. Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼" =1'-0" scale, double lined. Drawings shall indicate pipe layout and elevation, ductwork layout and elevation, and all equipment with manufacturers' recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items involved: (Submit 3 hard copies of all documents to Architect for Review

1. Double lined ductwork layout
2. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
3. Equipment layout
4. Piping and valves
5. Suspended ceiling components.
6. Structural members to which duct will be attached.
7. Size and location of initial access modules for acoustical tile.
8. Room walk paths and equipment access.
9. Penetrations of fire-rated construction.
10. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.

e. Access panels.

C. Welding certificates.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

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

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

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

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

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

    a. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

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

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

    1. Galvanized Coating Designation: G90 .
    2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

    1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Flexible Elastomeric Noise Reducing Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armacell LLC, Coilflex.
   b. Aeroflex USA Inc
   c. Rubatex International, LLC

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Minimum thermal conductivity: .25 BTU-in/h-ft^2-F
4. Rated for 180 degree F max and -297 degree F min
5. Noncorrosive
6. Antimicrobial
7. Sound transmission rating: 25
8. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

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

B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Adhere to duct with adhesive and secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

2.5 SEALANT AND GASKETS

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

B. Two-Part Tape Sealing System:

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

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.

4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant 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 HANGERS AND SUPPORTS

A. Hanger Rods: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

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

D. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

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

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

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

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

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

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

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

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

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

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

3.2 INSTALLATION OF EXPOSED DUCTWORK

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

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

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter.

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

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

3.3 DUCT SEALING

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

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. All ductwork: Seal class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Coordinate building attachments with pre engineered metal building manufacturer. Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

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

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

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

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

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

3.6 PAINTING

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

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Ducts with a Pressure Class Higher Than 2-Inch wg : Test representative duct sections no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give fourteen days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

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

E. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Ducts connected to air handling units-Supply, Return, Exhaust, and Outside Air:

1. Duct connected to Air-Handling Units:

a. Material

1) Ducts within the wash bay or chassis wash bay: Stainless steel
2) Ducts outside of the wash bay or chassis wash bay: Galvanized sheet steel

b. Pressure Class: Positive 3-inch wg Negative 2- inch wg
c. Minimum SMACNA Seal Class: A.
d. SMACNA Leakage Class for Rectangular: 24.
e. SMACNA Leakage Class for Round: 24

C. Exhaust Ducts:

a. Material
1) Ducts within the wash bay or chassis wash bay: Stainless steel
2) Ducts outside of the wash bay or chassis wash bay: Galvanized sheet steel Galvanized sheet steel

b. Pressure Class: Negative 2-inch wg.
c. Minimum SMACNA Seal Class: A.
d. SMACNA Leakage Class for Rectangular: 24.
e. SMACNA Leakage Class for Round: 24

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

E. Liner:

1. Supply and return Air Ducts specifically identified with an “L” after the duct size and as called out on drawings:
a. Flexible elastomeric noise reducing duct liner: 1 inches thick

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

    a. Rectangular Main to Rectangular Branch: 45-degree lateral or 90-degree with 45-degree entry.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 2000 fpm or Less: 45-degree lateral or 90-degree with 45-degree entryEND OF SECTION 233113

END OF SECTION

SECTION 23 3300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers
2. Manual volume dampers.
3. Control dampers.
4. Fire Dampers
5. Flange connectors.
6. Turning vanes.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Duct accessory hardware.
10. Flexible ducts.

1.3 ACTION SUBMITTALS

A. Product data

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish 1 for each damper requiring fusible links installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
   1. Description: Gravity balanced.
   2. Maximum Air Velocity: 2500 fpm.
   3. Maximum System Pressure: 2-inch wg.
   4. Temperature: 180 degrees F
   5. Frame: 18 gauge galvanized sheet steel, 3.5 in wide with welded corners and mounting flange.
   6. Blades: .025 in thick roll-formed aluminum, center-pivoted, with sealed edges.
   7. Blade Action: Parallel.
   8. Blade Seals: extruded vinyl
   9. Blade Axles:
      a. Material: Plated steel.
      b. Diameter: .1875 in
   10. Tie Bars and Brackets: 20 gauge galvanized steel (on-blade)
   11. Return Spring: Adjustable tension.
   12. Bearings: Acetal.
   13. Accessories:
      a. Adjustment device to permit setting for varying differential static pressure.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

   1. Manufacturers: provide products by one of the following:
      a. Greenehck Fan Corporation
      b. Nailor Industries Inc.
      c. Ruskin Company.

   2. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:

      a. Frame: Hat-shaped, 16 gauge, 5 inch deep, galvanized sheet steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.

   5. Blades:

      a. Single blade up to 12” high, multi blade over 12” high
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized, V-blade, 16 gauge but not less than two gauges more than the duct gauge

   6. Blade Axles: Galvanized steel, ½ inch diameter.
   7. Bearings:

a. Stainless-steel sleeve.
b. Dampers in ducts with pressure classes of 2-inch wg or more and on all dampers over 12 inch diameter shall have continuous rod axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

9. Include elevated platform for insulated duct mounting.

10. Damper handles:
    a. Cast alloy body and core
    b. Heavy stamped handle
    c. Locking
    d. Hex locking nut and acorn nut
    e. Basis of design: Duro Dyne, Specline or approved equal.

2.5 CONTROL DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Ruskin Company.

B. Insulated control dampers: low leakage,
1. 0.125 inch aluminum 5”x1” hat channel frame insulated with polystyrene on four sides and thermally broken with dual polyurethane resin aps.
2. Damper blades shall be heavy gauge extruded aluminum airfoil shape with metal blade to blade overlap. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Blade orientation is horizontal, and operation is parallel (on/off) or opposed (modulating), refer to drawings for further detail. Blades to be internally insulated polyurethane foam and thermally broken blade and jamb seals to be silicone rubber and external blade-to-blade linkage.
3. Each blade stop (at top and bottom of damper frame) shall occupy no more than ½” of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper
4. Linkage: Concealed in frame out of the airstream, plated steel material
5. Bearings to be dual bearing with acetal inner sleeve, flanged outer bearing resulting in no metal-to-metal or metal-to-plastic contact.
6. Dampers shall have a maximum leakage of 8 cfm/ sq. ft. @ 4 in. wg or 3 cfm/ sq. ft. @ 1 in. wg. at -40°F. Tested in accordance with AMCA standard 500-D.
7. Dampers shall have a maximum differential pressure rating of 4 in. wg
8. Dampers shall have a maximum velocity rating of 4000 fpm
9. Axles: Minimum ½ inch dia. plated steel. Stainless steel axle is optional. Removable control shaft extends 6" beyond the damper frame Dimension per drawings. Provide multi section damper as noted.
10. Finish: Mill Galvanized finish is standard

11. Temperature Rating: -70° F to 200° F
12. Control damper actuators: internal mount, 24 volt, refer to instrumentation and controls spec 230900 for further detail.
13. OCI switch (where indicated on drawings)- Two position indicator switch directly linked to damper blade to remotely indicate damper blade position

C. Non- insulated control damper
1. Dampers shall have a maximum leakage of 8 cfm/ sq. ft. @ 4 in. wg.
2. Dampers shall have a maximum differential pressure rating of 5 in. wg
3. Dampers shall have a maximum velocity rating of 3000 fpm
4. Damper frame shall be 16 ga. galvanized steel formed into a 5” x 1” structural hat channel. Top and bottom frame members on dampers less than 17” high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½” (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.
5. Blades: Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1” deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal. Blade operation is parallel
6. Each blade stop (at top and bottom of damper frame) shall occupy no more than ½” of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper
7. Blade Edge: Blade seals shall be TPE which are mechanically fastened to each blade.
8. Jamb: Flexible stainless steel compression type
9. Linkage: Concealed in jamb, plated steel material.
10. Axles: Minimum ½ inch dia. plated steel
11. Bearings: Axle bearings shall be synthetic (acetal) sleeve rotating in polished extruded holes in the damper frame.
12. Finish: Mill Galvanized finish is standard
13. OCI switch (where indicated on drawings)- Two position indicator switch directly linked to damper blade to remotely indicate damper blade position
14. Control damper actuators: external mount, 24 volt, refer to instrumentation and controls spec 230900 for further detail

2.6 FIRE DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Galvanized curtain style

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.7 FLANGE CONNECTORS

A. Interior
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ductmate Industries, Inc.
   b. Nexus PDQ; Division of Shilco Holdings Inc.
   c. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
2. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
3. Material: Galvanized steel.
4. Gage and Shape: Match connecting ductwork.

B. Exterior
1. Basis-of-Design Product: Subject to compliance with requirements, provide Basis-of-Design product name or comparable product by one of the following:
   a. Ductmate Industries, Inc. (Basis-of-Design)
   b. Nexus PDQ; Division of Shilco Holdings Inc.
   c. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
2. Description: Add-on factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
3. Material: PVC coated galvanized steel with integral sealant.
4. Gage and Shape: 20 Gage Roll-formed.
5. Gasket: 440 Butyl.
6. Cleat: PVC (polyvinyl chloride).
   a. Corner Clips: Bolted, 16 Gage PVC coated

2.8 TURNING VANES

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

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces, stainless steel, and 1.3 lb insulation filled blades.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements,provide products by one of the following:
1. Ductmate Industries, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
c. Access Doors up to 24 by 48 Inches Continuous and two compression latches with outside and inside handles.

2.10 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.12 FLEXIBLE DUCTS

A. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at outlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Provide volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel. Dampers shall be provided as necessary to achieve a NEBB certified air balance.

1. Install steel volume dampers in steel ducts.
2. Install stainless steel volume dampers in stainless steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. Upstream from duct filters.
2. On both sides of duct coils.
3. At outdoor-air intakes and mixed-air plenums
4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
5. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
6. At each change in direction and at maximum 50-foot spacing.
7. Upstream from turning vanes.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches .
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 3-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
   1. Do not provide a flexible connection to the HRU's. Provide a hard duct connection.

O. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped in place with stainless steel band clamps.

P. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Verify all dampers are secured and handles can be correctly fastened to hold damper in place

END OF SECTION

SECTION 23 3423

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. In-line centrifugal fans.
2. Ceiling-mounted ventilators

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

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

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Fan speed controllers.
7. Wiring diagrams

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Produced in electronic format (compatible with Autocad 2008) Detailed at ¼” =1’-0” scale, double lined. Drawings shall indicate pipe layout and elevation, ductwork layout and elevation, and all equipment with manufacturers’ recommended maintenance access. The following items shall be shown and coordinated with each other, using input from installers of the items involved: (Submit 3 hard copies of all documents to Architect for Review):

1. Equipment installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to layout.
2. Roof framing and support members relative to duct penetrations.
3. Suspended ceiling components.
4. Structural members to which duct will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Penetrations of smoke barriers and fire-rated construction.
7. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Field quality-control reports.

D. Startup service reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

B. Include vendor contact information for service and warranty

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be fully tested and documented to operate as a complete system.

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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

G. UL Standards: Power ventilators shall comply with UL 705.

1.9 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance.
   1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from substantial completion. Any units or parts which prove defective during the warranty period will be replaced, transportation prepaid
   2. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station

B. For Labor: One year(s) from date of Substantial Completion

1.10 PREVENTATIVE MAINTENANCE PROGRAM- (ALTERNATE M-2)

A. OEM Startup is performed by OEM factory-trained and authorized servicing technicians confirming all HVAC equipment and controls have been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.

B. Provide a 2-year OEM preventive maintenance program meeting the following requirements:
   1. Provide four quarterly visits per year to perform maintenance tasks per manufacturer’s installation, operation, and maintenance (IOM) manual.
   2. Persons performing the above tasks are to be an OEM’s, factory-trained and authorized servicing technicians

1.11 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 IN-LINE BELT DRIVEN CENTRIFUGAL FANS- GENERAL EXHAUST (EF-1,2,3 & RAF)

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

   1. Greenheck Fan Corporation.
   2. Loren Cook Company.

3. Carnes.

B. Wheel:
1. Non-overloading, backward inclined centrifugal wheel
2. Constructed of aluminum
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
5. Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone

C. Motor:
1. Motor enclosures: Open driproof
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase

D. Shafts and Bearings
1. Fan shaft shall be ground and polished solid steel with an anti corrosive coating
2. Permanently sealed bearings or pillow block ball bearings
3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
4. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

E. Housing/Cabinet construction
1. Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
2. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly

F. Housing Supports and Drive Frame
1. Housing supports to be constructed of structural steel with formed flanges.
2. Drive frame to be welded steel which supports the shaft and bearings and reinforcement for the housing
3. Provide pivoting motor plate with adjusting screws to accommodate belt tensioning operations

G. Drive assembly
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
2. Belts: Static free and oil resistant, standard
3. Pulleys: Cast type, keyed, and securely attached to wheel and motor shafts
4. Motor pulleys are adjustable for final system balancing
5. Readily accessible for maintenance

H. Duct collars
1. Provide inlet and discharge collars to provide easy duct connection

I. Access Panel
1. Two sided access panels, permit easy access to all internal components

J. Finish- High pro polyester- one part coating, resistant to salt water, chemical fumes, and moisture.

K. Accessories:
1. Belt Guard
   a. Three-sided fabricated steel belt guard covers drive and motor.
2. Motor cover
   a. Constructed of galvanized steel to cover motor and drives.
3. Inlet companion flange
4. Outlet companion flange
5. Inlet flex duct connection
6. Extended lube lines
7. Vibration isolators
   a. Restrained spring mount- type 4A, 1 inch deflection, laterally stable, free standing springs assembled into steel housing.

L. Capacities and Characteristics:

1. Refer to schedules on drawings for capacities and characteristics.

2.2 IN-LINE BELT DRIVEN CENTRIFUGAL FANS- SPARK RESISTANT CONSTRUCTION- (EF-4 THRU 12)

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. Carnes.

B. General construction- AMCA fan class A to accommodate spark resistant construction.
1. Fan to be electrically grounded to prevent static electricity from building up.

C. Wheel:
1. Non-overloading, backward inclined centrifugal wheel
2. Constructed of aluminum
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
5. Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone

D. Motor:

1. Motor enclosure: explosion resistant enclosure- totally enclosed motor, with a housing constructed to contain and explosion whin the motor caused by the hazardous atmosphere entering the enclosure and being ignited.
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase

E. Shafts and Bearings

1. Fan shaft shall be ground and polished solid steel with an anti corrosive coating
2. Permanently sealed bearings or pillow block ball bearings
3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
4. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

F. Housing/Cabinet construction
1. Square design constructed of aluminum and shall include square duct mounting collars
2. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly

G. Housing Supports and Drive Frame
1. Housing supports to be constructed of structural steel with formed flanges.
2. Drive frame to be welded steel which supports the shaft and bearings and reinforcement for the housing
3. Provide pivoting motor plate with adjusting screws to accommodate belt tensioning operations

H. Drive assembly
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
2. Belts: Static free and oil resistant, standard
3. Pulleys: Cast type, keyed, and securely attached to wheel and motor shafts
4. Motor pulleys are adjustable for final system balancing
5. Readily accessible for maintenance

I. Duct collars
1. Provide inlet and discharge collars provide easy duct connection

J. Access Panel
1. Two sided access panels, permit easy access to all internal components

K. Finish- Industrial epoxy- thermosetting epoxy powder with chemical resistance to a wide variety of chemicals and moisture.

L. Accessories:
1. Belt Guard
   a. Three-sided fabricated steel belt guard covers drive and motor.
2. Motor cover
   a. Constructed of galvanized steel to cover motor and drives.
3. Inlet companion flange
4. Outlet companion flange
5. Inlet flex duct connection
6. Extended lube lines
7. Vibration isolators
   a. Restrained spring mount- type 4A, 1 inch deflection, laterally stable, free standing springs assembled into steel housing.

M. Capacities and Characteristics:

1. Refer to schedules on drawings for capacities and characteristics.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support suspended units from structure using threaded steel rods and neoprene/rubber isolators having a static deflection of 1 inch.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Provide flex connection at the inlet and outlet of the fan for connection to ductwork.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 CLEANING

A. On completion of installation, internally clean fans according to manufacturer’s written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, include outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

SECTION 23 3600

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Shutoff, single-duct air terminal units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

   1. Air terminal units.
   2. Liners and adhesives.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. Insulation shall meet NFPA 90A requirements for flame spread and smoke generation and UL 181 requirements for anti-erosion, corrosion and fungus properties.

C. Hot water coils shall be tested for leakage at 400 psig with the coil submerged in water.

D. Sound power levels shall be AHRI certified in accordance with the requirements of AHRI 880.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

2.2 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.

2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier
   2. Nailor Industries Inc.
   3. Price Industries.

B. Description: Unit shall be a single-duct, variable air volume terminal unit with control box for installation in a ceiling that permits access to the unit. Manufacturer shall supply unit(s) of the design, number, size and performance as shown on equipment drawings and schedules. Unit(s) are for use in conjunction with air distribution manifolds, distribution ductwork and ceiling-mounted diffusers.

C. Factory-assembled, externally powered, variable air volume control terminal. Unit shall be complete with a damper assembly, flow sensor, externally mounted volume controller, collars for duct connection and all required features. Control box shall be clearly marked with an identification label that lists such information as nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil hand,

D. Constructed of 20-gage galvanized steel with round or rectangular inlet collar and rectangular discharge with slip and drive connection. All primary air inlet collars shall accommodate standard flex duct sizes

E. Insulation- 13/16-in., 4 lb density, rigid duct board insulation with nylon reinforced foil material covering the insulation fibers. The insulation shall meet UL 181 and NFPA 90A. The lining shall be attached to the terminal unit casing by insulation adhesive and full-seam length steel Z-strips which enclose and seal the insulation cut edges, thus eliminating tape and adhesives to cover the cut edges.

F. Damper Assembly-The control air damper assembly shall be constructed of heavy gage steel with solid shaft rotating in Delrin bearings. Damper shaft shall be marked on the end to indicate damper position. Damper blade shall incorporate a flexible gasket for tight airflow shutoff and operate over a full 90 degrees

G. Controls- Unit to be supplied with control cabinet to accommodate controls by DDC system.
   1. The unit shall be equipped with an amplified linear averaging flow probe located across the inlet. The sensor will provide a differential pressure signal amplified to equal 3 times the velocity pressure with an accuracy of at least ±10% throughout the range of 350 to 2600 fpm inlet duct velocity, depending on the controller employed

H. Hot water heating coil
   1. Coil shall be mounted in a minimum 20 gage galvanized steel casing with slip and drive discharge connections, and factory mounted on the base unit as shown on the equipment drawings. Coils shall have:
      a. Aluminum fins (10 fins/in.) bonded to the copper tubes by mechanical expansion.
      b. Number of coil rows and circuits shall be selected to provide performance as required by the plans.
      c. Right or left-hand fittings with sweat connection sizes

I. Access Panel:
   1. An access panel in the terminal unit casing shall be available for viewing damper components and for upstream cleaning of the hot water coil fins.

J. Hanger Brackets: Shall be factory furnished field-installed for use with ceiling installation of the terminal unit

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Coordinate with building manufacturer.
   1. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to supply with shutoff valve, strainer, and union or flange; and to return with automatic flow balancing valve and union or flange.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts”.

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. 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 air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air terminal unit will be considered defective if it does 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.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 23 3713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ceiling diffusers.
2. Linear slot diffusers.
3. Fixed face registers and grilles.

B. Related Sections:
1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATION SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Square Ceiling Diffusers:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Devices shall be specifically designed for variable-air-volume flows.
3. Construction: Precision formed back cone of one-piece seamless construction that incorporates a round Intel collar of sufficient length for connecting rigid or flexible duct.
4. An inner plaque assembly shall be incorporated and shall drop no more than a ¼ inch below the ceiling plane to assure proper air distribution performance.
5. The inner plaque assembly shall be completely removable from the diffuser face to allow for full access to any dampers or other ductwork components located near the diffuser neck.
6. Material: Steel for all applications other than restrooms. Aluminum in restrooms.
7. Finish: powder coat, color selected by Architect.
8. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering per ASTM D610 and ASTM D714.
9. Air pattern: 360 degree radial horizontal.
10. Face Size: Indicated on drawing per location.
11. Face Style: Plaque.
12. Mounting: Coordinate with architectural ceiling types for each diffuser shown and provide mounting frame specific for each ceiling type.
13. Dampers: Radial opposed blade.
14. Accessories:

    a. Equalizing grid.

2.2 LINEAR SLOT DIFFUSERS

A. Linear Slot Diffuser:

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Devices shall be specifically designed for variable-air-volume flows.
3. Construction: The diffuser border shall be heavy extruded aluminum construction with extruded aluminum spacers and mitered end flanges, open ends, flush end caps or angle end caps.
4. Joiner strips shall be provided to align continuous slot assemblies.
5. Finish - Face and Shell: Powder coat, color selected by Architect.
6. Finish - Pattern Controller: Powder coat, black.
7. Finish - Tees: Powder coat, color selected by Architect.
8. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering per ASTM D610 and ASTM D714
9. Slot: ¾” wide with aerodynamically curved “ice tong” shaped pattern control.

10. Number of Slots: Indicated on drawings per location.
11. Length: Indicated on drawings per location.
12. Air pattern: 180 degree adjustable horizontal
13. Accessories:
    a. Factory fabricated and insulated plenum box sized for the length of the diffuser.
        1) Construction: zinc coated steel
        2) Plenum assemblies shall be of a side inlet configuration
        3) Plenum shall have sloped shoulders for enhanced spread characteristics.
        4) Provide curved factory built plenums to accommodate curved diffuser
14. Coordinate with architectural ceiling types for each linear slot outlet shown and provide mounting frame specific for each ceiling type.

2.3 FIXED FACE REGISTERS AND GRILLES

A. Fixed Face Supply Register

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Registers shall be double deflection type with two sets of fully adjustable deflection blades spaced ¾ inch on center. The front blades shall run parallel to the long dimension of the register.
3. Material: Steel.
4. Finish: Powder coated, color selected by Architect.
5. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering per ASTM D610 and ASTM D714
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Welded with precision mitered corners.
8. Mounting: Countersunk screw.
9. Damper Type: Cold rolled steel adjustable opposed blade. Damper shall be operable from the register face.

B. Fixed Face Return and transfer Register

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Registers shall be 45 degree deflection fixed louver type with blades spaced ½ inch on center. The front blades shall run parallel to the long dimension of the register.
3. Material: Steel.
4. Finish: Powder coated, color selected by Architect.
5. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering per ASTM D610 and ASTM D714
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Welded with precision mitered corners.
8. Mounting: Countersunk screw.
9. Damper Type: Cold rolled steel adjustable opposed blade. Damper shall be operable from the register face

C. Fixed Face Exhaust Register

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Registers shall be 45 degree deflection fixed louver type with blades spaced ½ inch on center. The front blades shall run parallel to the long dimension of the register.
3. Material: Aluminum
4. Finish: Powder coated, color selected by Architect.
5. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering per ASTM D610 and ASTM D714
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Welded with precision mitered corners.
8. Mounting: Countersunk screw.
9. Damper Type: Mill finish aluminum adjustable opposed blade. Damper shall be operable from the register face

2.4 DRUM DIFFUSER

A. Drum diffuser

1. Performance: Subject to compliance with requirements and related documents, provide products meeting a minimum performance of the following:
2. Outlets shall consist of individually adjustable spread control vanes housed with a rotatable drum
3. Drum to be adjustable through 60 degrees. Positive detent mechanism to fix drum and setting
4. Adjustable vanes are to pivot and maintain blade settings.
5. Mounting frame: The border shall be constructed of formed steel with welded, reinforced corners.
6. Mounting: Countersunk screws
7. Material:
   a. Curved outer drum and vanes: extruded aluminum
   b. All other components: Steel
8. Finish: Powder coated, color selected by architect.
9. Damper: Provide a integral control damper with opposed blades constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 4500

GAS DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMNTS

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

1.2 SUMMARY

A. This Section includes gas detection instruments and other components necessary for an emergency gas exhaust system.

B. Related Sections:

1. Section 230993 “Sequence of operation of HVAC controls”

1.3 DELIVERY, STORAGE, AND HANDLING

A. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

B. Lift and support units with manufacturer's designated lifting or supporting points.

1.4 DESCRIPTION:

A. The work to be performed in accordance with these Specifications includes engineering, final system and component configuration design, manufacture, procurement, delivery, storage, installation, equipment calibration, testing, documenting, warranting, maintenance and the placing in service of carbon monoxide, nitrogen dioxide and methane detection and alarm system

B. The work shall include the furnishing and installation of equipment, material, conduit, cables, mounting hardware, system operating software and all appurtenances required to provide complete, coordinated and compatible operating systems with functional subsystems and elements which meet the requirements described in these Contract documents. All other materials and equipment, including items such as; samples, prototypes, cable termination allowances, packing materials, wastage of material during installation efforts and tests, demonstrations, engineering review documentation, and any other materials or services associated with the prosecution of the work or the administration of the Contract that are not listed, but are otherwise specified or necessary for full and complete operation and performance

of each system, shall also be provided by the Contractor. The Contract price provides full compensation for complete operational systems and all items and work furnished by the Contractor in compliance with this provision.

C. The Gas Detection and Alarm System to be provided shall be a microprocessor based, distributed control system with industry standard hardware and software to detect the presence of carbon monoxide, nitrogen dioxide and methane in the maintenance garage and to provide warning alarms to personnel located within and in the immediate surroundings of maintenance garage.

D. The system shall operate over a fault tolerant three-wire communication network loop with built-in diagnostics, programmable logic, non-volatile memory for alarm and calibration logging and accommodate a variety of other fire and gas devices. It shall be designed to ignore opens and shorts that could occur on the network. The loop configuration will ensure a single short or open on the system will not affect system communication between the field devices and the control unit. System communication will provide supervision of all addressable devices on the network and provide fault alarms in the event of system failures

1.5 SYSTEM PERFORMANCE REQUIREMENTS:

A. This Section shall be considered by the Contractor to be based primarily on System Performance Requirements. Minimum acceptable technical characteristics have also been specified for major items of equipment and certain materials and services in order to maintain desired standards of quality, and to ensure that interchangeability; maintainability and reliability goals of the Authority are achieved.

B. The Gas Detection and Alarm System shall continuously monitor the carbon monoxide, nitrogen dioxide and methane levels within the spaces in which they are located. Set points for each detector shall be as follows:

a. Carbon Monoxide, Nitrogen Dioxide, and Methane: The carbon monoxide detector shall detect the presence of carbon monoxide at any location within the maintenance garage in concentrations of 0% to 100%.

b. Gas detection system to initiate a low level alarm A when the level of gas reaches the following concentrations.

i. Carbon Monoxide- 25 ppm

ii. Nitrogen dioxide- .7 ppm

iii. Methane- 25% LEL.

c. Alarm B to be initiated when the level of gas reaches to following concentrations

i. Carbon Monoxide- 200 ppm

ii. Nitrogen dioxide- 2 ppm

iii. Methane- 50% LEL

d. Alarm C to be initiated when the level of gas reaches to following concentrations

i. Carbon Monoxide- 225 ppm

ii. Nitrogen dioxide- 9 ppm

iii. Methane- 90% LEL

C. The Gas Detection and Alarm System shall interface with the respective building ventilation systems and roll-up door controllers to enable the fans and open the roll-up doors when the concentrations reach the levels described above.

D. Refer to specification 230993 "sequence of operation" and contract drawings for further information.

E. The Gas Detection and Alarm System shall operate satisfactorily in the environment existing in the maintenance garage. With the exception of normal cleaning requirements, the system operation shall not be compromised and false alarms shall not be generated by detectors exposed to normal levels of dust, smoke, moisture, chemicals and fumes from petroleum distillates.

F. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the Local Control Unit.
4. Ground or a single break in Local Control Unit internal circuits.
5. A break in standby battery circuitry.
6. Failure of battery charging.
7. Abnormal position of any dip switch at the devices so equipped.

G. System Trouble Signal Actions: Ring trouble bell and energize LED or lamp on the graphic annunciator panel. Sound a chime tone and display trouble alarm with description on the computer monitor. Record the event in the system historical log. Trouble alarms shall be cleared only after the system fault has been corrected and a system reset function has been completed.

1.6 ACTION SUBMITTALS:

A. General: Submit the following according to General Conditions of the Contract and Division 1 specification sections.

B. Product Data: Include manufacturer's name, model numbers, data sheets, ratings, power requirements, equipment layout, device arrangement, and battery calculation charts. Show the control panel module layouts, remote annunciator panel configurations and wiring terminations.

C. Complete detector system wiring point-to-point diagrams, conduit layouts (show penetrations for fire rated walls).

D. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and corresponding outputs. Description shall cover this specific project. Manufacturer's standard descriptions for generic systems are not acceptable and any submitted materials containing information which is not relevant to this project shall have the irrelevant information crossed out or otherwise deleted.

E. Shop Drawings:

1. Complete drawing lists for each system.
2. Complete installation drawings for each system.
3. System riser diagram with device addresses, conduit sizes and cable and wire types and sizes.
4. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
5. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
6. Complete technical characteristics and specification details for each system.
7. Complete assembly drawings for each system and all developed equipment.
8. Complete test procedures for each system and each item of equipment requiring such procedures.
9. Complete interface control details and procedures.
10. Complete sequence of operation.

1.7 INFORMATION SUBMITTALS

1. Field quality-control reports.

2. Startup service reports.

3. Warranty: Sample of special warranty

1.8 CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: Contractor shall include the following information in the operations and maintenance manual:

   a. A copy of all approved submittals.
   b. Hard copy and CD of Record (As Built) drawings for all equipment items for each system.
   c. Complete test data for each system and all equipment for which such data is approved.
   d. Other submissions listed elsewhere in these Specifications, as required by the Authority's Representative.

1.9 QUALITY ASSURANCE:

A. The manufacturer of the major components of the Gas Detection and Alarm System shall have a minimum of 5 years experience in the manufacturing of gas detection equipment and have provided equipment for similar applications in bus maintenance facilities. The satisfactory operation of systems previously provided shall be subject to verification. Manufacturer must be ISO 9002 certified.

B. All major components of the Gas Detection and Alarm System, including software, shall be furnished from the same manufacturer.

C. The equipment supplier shall participate in the applications engineering, set up, testing and commissioning of the system.

D. Non-dispersed, infrared gas detectors shall be warranted against failure by the manufacturer for a minimum of five years and require calibration only on an annual basis. The gas detectors shall permit calibration to be performed by one person.

E. The system shall be installed by qualified electricians who have successfully completed a training course provided by the equipment supplier.

F. Unless otherwise specified to exceed the listed requirements, all gas detection and alarm systems designs, clearances, construction, electrical and mechanical installations, structural designs, materials and testing shall, as a minimum, be in accordance with the requirements in effect at time of Invitation for Bid for each of the following and shall include addenda and supplements:

1. FMRC NFPA 72 - National Fire Alarm Code
2. Fire Code of the local jurisdiction
3. FM 6310/6320 - Combustible Gas Performance
4. National Electrical Code (NEC).
5. FMRC 6310/6320 Combustible Gas Detectors
6. Building Officials and Code Administrators National Building Code (BOCA).
7. Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).

G. The specifications are not to be construed as supplanting any code requirements.

1.10 WARRANTY

A. Warranty Period:
1. For Labor: One year from date of Substantial Completion
2. For Parts: One years from date of Substantial Completion

1.11 CONTRACTOR'S TOTAL SYSTEM RESPONSIBILITY:

A. The Contractor bears total system responsibility for the specified gas detection and alarm system (except Contract deliverables not requiring Contractor installation). The Contractor's total system responsibility includes engineering services, construction, testing, installation documentation, warranty, maintenance, and other areas of responsibility, which are subject to periodic review and acceptance by the Authority (as specified elsewhere). The Contractor has the responsibility to integrate the various necessary elements of Contract work so that overall system performance goals are met.

B. The Contractor is required to engage the services of the approved system manufacturer's engineering staff to evaluate the facilities for appropriate applications of gas detection and alarm equipment.

C. The Gas Detection and Alarm System shall comply with all applicable national and local codes.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT:

A. The system shall be Honeywell or approved equal and shall be comprised of a control unit, a programmable relay module, addressable infrared gas detectors, initiating device circuits, notification appliance circuits, and analog initiating devices with control unit(s) communicating over a high speed fault tolerant communications link to form an integrated system.

B. All field devices shall have 3/4 inch NPT cable entry and separate terminals for incoming and outgoing field wiring. Terminals shall be sized to accept 16 to 22 AWG wire.

C. All detector locations shall permit the separation from the transmitter for a distance up to 20 feet for methane detectors and 50 feet for carbon monoxide and nitrogen dioxide detectors. Transmitters shall have the capability to simulate and adjust the output to compensate for line loss and allow field testing. Conduit and cabling between the detector and remote transmitter shall be rated for installation in hazardous locations. The transmitter shall display Gas Concentration and Alarm Status as a minimum.

D. The alarm devices shall be a combination horn and visual alarm. Alarm Horns shall operate on 24 VDC, provide 85 db at 10 ft, be corrosion resistant and be NEMA 4X rated. Visual Alarm shall operate on 24 VDC, provide 60 flashes per minute and be NEMA 4X rated.

E. Wire and cable shall be UL listed with color coded insulation appropriate for the area of installation. Cable shielding, conductor configuration and sizing shall be as recommended by the system manufacturer. All system wire and cabling installed outside of equipment enclosures and devices shall be installed in rigid galvanized steel conduit.

F. Provide grounding of system equipment and cable shielding as recommended by the system manufacturer. Grounding shall comply with IEEE 1100.

2.2 LOCAL CONTROL UNIT

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

1. Honeywell (Basis of design Model VA301C)

B. Power Requirements: 17-27 Vac, 60 Hz or 24-38 Vdc, 500 mA
C. Operating Temperature Range: -4°F to 122°F
D. Operating Humidity Range: 0 to 95% RH (non-condensing)
E. Outputs: 4 DPDT relays
F. Relay Output Rating: 5A, 30 Vac
G. Network Capacity: Up to 96 transmitters
H. Alarm levels: 3 fully programmable alarm levels
I. Communication Cable: Twisted and shielded 2-24 AWG
J. Length of Communication Lines: 2000ft per channel
K. Audible Alarm: 65 dBa at 3ft
L. Battery: 3V Lithium Battery
M. Enclosure: NEMA 4X ABS polycarbonate
N. The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 Modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 24 Vac or 24 Vdc
O. The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load)
P. The controller to include a self-test function that allows for the activation/deactivation of all the programmed outputs by simulating a continuous 5% increase/decrease value until the maximum/minimum value is reached.
Q. The controller to include a real-time clock that enables operation of the outputs for a specific timeframe.
R. The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group (¾, ½, ⅓ and ¼) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.
S. The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.
T. Data logging
   a. Data logging capability to provide long-term data logging to determine trends. The controller must collect data automatically and must store it on a digital Flash media card.

2.3 EXPLOSION PROOF INFRARED METHANE DETECTOR

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

   a. Honeywell (Basis of design Model XCD)

B. Power Requirement: 24Vdc

C. Relay Output: 5A @ 30 Vdc. Selectable normally open or normally closed (switch) and energized/de-energized (programmable)
D. Communications: RS485 Modbus
E. Infrared gas sensor
F. Housing: Epoxy painted aluminum alloy LM25, sensor- 316 stainless steel
G. Accuracy: +/- 1.5% of full scale
H. Gases Detected: Methane (CH4)
I. Transmitter to be powered by the control panels power output rated at 17-27 VDC. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter to incorporate an infrared (IR) type sensor for monitoring methane gas. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.
J. When placed in a network configuration the transmitter to be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an optional DPDT relay 5A, 30 Vdc or 250 Vac (resistive load) to be activated at programmable set points (and programmable time delays) through the control panel. A 10-step LED display (with an optional LCD display) will provide gas concentration readings. Normal operation to be indicated by a green LED; fault operation to be indicted by a yellow LED.
K. Transmitter to be capable of operating within relative humidity ranges of 5-95% and temperature ranges of -40o F to 131o F (-40o C to +50o C).
L. Unit to be manufactured to ANSI/UL 61010-1 label and CSA 22.2. Transmitter must be manufactured within an ISO 9002 production environment.

2.4 TOXIC AND COMBUSTIBLE GAS DETECTOR- CARBON MONOXIDE AND NITROGEN DIOXIDE

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

1. Honeywell (Basis of design Model E^3Point)

B. Power Requirement: 24 Vac nominal or 24Vdc, 60 Hz, 0.4A
C. Relay Output: 1 DPDT relay, 5A @ 250 Vac; 5A @ 30 Vdc
D. Communications: RS485 Modbus
E. Operating Temperature: -40° to 122°F
F. Display: 8 Character, 2 line backlit LCD
G. Visual Indicator: Green LED: Power; Amber LED 1: Alarm/Fault; Amber LED 2: Alarm/Fault
H. Audible Alarm: 85 dBA at 10ft
I. Accuracy: +/- 3% of full scale
J. Gases Detected: Carbon Monoxide (CO), Nitrogen Dioxide (NO_2)
K. Transmitter will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of -4° F to 104° F (-20° C to 40° C)
L. Enclosure: Polycarbonate
M. Transmitter to be powered by the control panel power supply rated at 24 Vac or 24 Vdc. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases.

Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy

N. When placed in a network configuration the transmitter to be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 Vdc or 250 Vac (resistive load) to be activated at programmable set points (and programmable time delays) through the control panel. An LCD display to provide gas concentration readings.

O. Unit will be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-2000 production environment.

P. The transmitter should have a plug-in capability for a gas cartridge with a smart sensor capable of self-testing

Q. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft (3 m).

R. Provide splash guard enclosure (Honeywell ECLAB or approved equal) within wash down areas.

S. Provide detector guards (Honeywell E3PT-Guard or approved equal)

   a. Grid to be made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards

2.5 STROBE AND HORN

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

   1. Honeywell (Basis of design Model P2W-P)

B. Strobe & Horn combo unit will be capable of operating within relative humidity ranges of 0-100% and temperature ranges of -30° F to 150° F (-35° C to 66° C). Rating of horn will be no less than 90dB at 10 feet. Intensity of light will be no less than 40W and will flash at a frequency of 1 per second

2.6 SYSTEM RELAY MODULE

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

   1. Honeywell (Basis of design Model VA301R8)

B. Fully compatible with the 301C Controller

C. Capable of 8 additional DPDT relays, 5A, 30Vdc or 250Vac

D. Easy daisy chain installation (RS-485)

E. LED visual indication of status next to each relay

F. Connects into a single output of the 301C Controller

G. Operating Temperature: 32° to 104°F

H. Humidity Range: 0-95% RH, non-condensing

I. Power Requirements: 17-27Vac, 24-28Vdc

J. Relay module will be powered by the control panel's power output. Module to be capable of communicating digitally with the controller through an RS-485/MODBUS communication port. Relay module will have eight relays rated at no lower than 5A, 30 Vdc or 250 Vac (resistive load).

PART 3 - EXECUTION

3.1 INSTALLATION:

A. All equipment installation shall comply with applicable codes and shall be performed with a degree of workmanship acceptable to Precision Strip. Final terminations of Gas Detectors, Transmitters, Receivers/Controllers and Supervisory System must be performed by factory authorized and trained service personnel.

B. Control equipment shall be located at locations shown on contract drawings. Control equipment enclosures and cabinets shall be wall mounted at a height with the top of the enclosure or cabinet not exceeding six feet above the floor. Install all items in accordance with manufacturer's instructions Equipment located within 18 inches below the ceiling shall comply with requirements for areas with hazardous classification per NFPA.

C. Methane detectors shall be located between 20 inches below underside of roof deck.

D. Carbon monoxide detectors shall be located between 3 feet and 5 feet above floor.

E. Nitrogen dioxide detectors shall be located between 1foot and 3 feet below underside of roof deck.

F. Install wiring in conduit.

G. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace and train conductors to terminal points with no excess. Connect conductors that are terminated or interrupted in any enclosure associated with the gas detection and alarm system to terminal blocks. Label each terminal and wire according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

H. Cable Terminations: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

I. Color-Coding: Color-code Gas Detection and Alarm System conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices.

J. All wiring used for communication over Ethernet network shall be shielded.

3.2 TESTING:

A. Contractor shall engage a factory-authorized service representative to assist in inspecting, testing, and adjusting components, assemblies, and equipment installations, including connections. Report results in writing.

B. Component Level Tests and Inspections:

1. The contractor shall prepare detailed pre-test check sheets, test plans, procedures, data entry forms and test reports for the testing of each component.
2. The test plans shall provide objectives, approach, pass/fail criteria, requirements and schedule for each test.
3. Test and adjust all controls and safeties.
4. Verify each component is installed at the correct height indicated.
5. Verify each component is installed securely.
6. Verify electrical connections to each component are correct and secure.
7. Test all functions within each individual components control.
8. Test audible and visual alarms on each component
9. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. System Level Tests and Inspections:

1. The contractor shall prepare detailed pre-test check sheets, test plans, procedures, data entry forms and test reports for the testing of the entire gas detection system.
2. The test plans shall provide objectives, approach, pass/fail criteria, requirements and schedule for each test.
3. Test and adjust all controls and safeties.
4. Verify the absence of unwanted voltages between circuit conductors and ground.
5. Test all conductors for short circuits utilizing an insulation-testing device.
6. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit.
7. Verify the control unit is in the normal condition as detailed in the manufacturers operating and maintenance manuals.
8. Test each detector for operation and proper response at the control unit. Test detectors with actual carbon monoxide, nitrogen dioxide or methane gas as appropriate for each detector.
9. Test the system for all specified functions according to the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
10. Verify that all HVAC equipment is functioning properly with the detection control unit.
11. Verify all relays are performing correctly to start-up HVAC equipment and open garage doors.
12. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Furnish equipment required to perform all tests. Test each component installation and system in accordance with the approved procedures.

F. The Contractor shall notify the owner a minimum of two working days prior to commencing any tests that are to be witnessed by the owner.

G. The Contractor shall furnish personnel, tools and test equipment as required to satisfactorily complete the tests. Test equipment used in performing the tests shall be in current calibration. Factory authorized service personnel shall provide all programming and verification of each Gas Detector, Transmitter, Receiver/Controller, Annunciator Panel and Supervisory System and the Factory authorized service personnel shall provide final test and verification of overall system performance.

H. Repair or replace malfunctioning units and retest as specified above.

I. Prepare and submit certified test reports for each equipment installation test indicating the results of all tests and remedial measures implemented to enable equipment to pass the tests.

J. System Performance Test (30 day): After completion and inspection of all work, and following placement of the gas detection and alarm system in service, the contractor shall perform a 30-day performance test. The performance test shall include an end-to-end test of all function of the system.

1. All detection, alarm and interface function s operate as intended in the event of an actual buildup of carbon monoxide, nitrogen dioxide or the release of compressed natural gas.
2. No false alarms
3. No system trouble or fault alarms
4. If the system, or any part of it, fails to meet any criteria of the performance test, the contractor shall make corrections at no additional cost to the owner. More than three failures during the thirty (30) day test will result in a restart of the test period.

3.3 DEMONSTRATION

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas detection devices and equipment. Training shall be a minimum duration of 4 hours and contractor shall provide all training materials and equipment.

3.4 SYSTEMS WARRANTY AND CONTRACTOR MAINTENANCE SERVICES:

A. The materials, equipment, workmanship and software for the systems and components furnished under this contract shall be warranted against defects for a period of 24 months from the date of final acceptance except for gas detectors which shall be warranted for a period of five years. The Contractor shall be responsible to replace or repair any failed equipment, software program or work, including labor, at no additional cost to the owner.

END OF SECTION

SECTION 23 5100

BREECHINGS, CHIMNEYS, AND STACKS

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. Double-wall vent.
   2. Single wall vent

B. Related Sections include the following:

   1. Division 23 Section "Draft Control Devices" for induced-draft and mechanical fans and for motorized and barometric dampers.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Double wall vent
   2. Single wall vent.
   3. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

   1. Detail equipment assemblies and calculations indicating dimensions, weights, loads, required clearances, methods of field assembly, components, hangers, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

D. Tested and Listed by Underwriters Laboratories UL 1738/ULC S636

1.6 COORDINATION

A. Coordinate location of wall penetrations.

1.7 WARRANTY

A. The Manufacturer shall warrant the Positive Pressure Vent System against defects in material and workmanship for a period of 15 years from the date of original installation. Any portion of the vent repaired or replaced under the warranty shall be warranted for the remainder of the original warranty period.

PART 2 - PRODUCTS

2.1 SINGLE-WALL VENT

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

1. Security Chimneys International
2. Heat-Fab, Inc- Saf- T vent CI plus
3. Metal-Fab, Inc.

B. The vent shall be of single wall, factory built type, designed for use in conjunction with Category I, II, III or IV condensing or non-condensing gas fired appliances or as specified by the heating equipment manufacturer

C. Maximum continuous flue gas temperature shall not exceed 550 degree F.

D. Vent shall be listed for a maximum positive pressure rating of 6” w.c. and shall have passed at 35” w.c.

E. The vent system shall be continuous from the appliance’s flue outlet to the vent termination outside the building. All system components shall be UL / cUL listed and supplied from the same manufacturer.

F. The vent shall be constructed from AL29-4C® stainless steel, with a minimum wall thickness of .020” for 3”through 12” diameter vents.

G. All system components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings require to install the vent system shall be UL listed and provided by the vent manufacturer.

H. Vent layout shall be designed and installed in compliance with manufacturers installation instructions and all applicable local codes

2.2 DOUBLE-WALL VENTS

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

1. Security Chimneys International
2. Heat-Fab, Inc- Saf- T vent CI plus
3. Metal-Fab, Inc.

B. The vent shall be of the double wall, factory built type, designed for use in conjunction with Category I, II, III or IV condensing or non-condensing gas fired appliances or as specified by the heating equipment manufacturer.

C. Maximum continuous flue gas temperature shall not exceed 550 degree F.

D. Vent shall be listed for a maximum positive pressure rating of 6” w.c. and shall have passed at 35” w.c.

E. The vent system shall be continuous from the appliance’s flue outlet to the vent termination outside the building. All system components shall be UL / cUL listed and supplied from the same manufacturer.

F. The vent shall be constructed with an inner and outer tube, where the annular air space between the tubes is 1inch.

The inner tube (flue gas conduit) shall be constructed from AL29-4C® stainless steel, with a minimum wall thickness of .020” for 4” through 12” diameter vents.

The outer tube (jacket) shall be constructed from 441 stainless steel, with a minimum wall thickness of .020” for 4” through 10” diameter vents.

G. All system components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings require to install the vent system shall be UL listed and provided by the vent manufacturer.

H. Vent layout shall be designed and installed in compliance with manufacturers installation instructions and all applicable local codes.

2.3 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:
   1. Minimum Size: 1/4 inch in diameter.
   2. For ID Sizes 4 to 15 Inches: 5/16 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Double-Wall insulated and non insulated vent: Gas-fired boilers.

B. Listed single-wall vent: Gas-fired boilers

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain through the condensate neutralization kit.

E. Lap joints in direction of flow.

F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.

H. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

I. Install insulated wall thimbles at exterior wall penetrations and uninsulated wall thimbles at interior wall penetrations. Install per manufacturers written instruction. Seal penetration with approved fire stop sealant on all sides.

J. The vent system shall be installed to maintain minimum clearance to combustibles as specified by the manufacturer.

K. Vent installation shall conform to the manufacturer's installation instructions, its UL listing and state /local codes

L. The vent system and breechings shall be inspected and cleaned before the final connection to the appliances

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

SECTION 23 5216

CONDENSING BOILERS

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, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
   1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler

B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 60%, and 5% input firing rates at incoming water temperatures ranging from 60°F to 160°F. Test protocols shall be witnessed and reviewed by an independent, third-party group

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Source-quality control reports

C. Field quality-control reports.

D. Startup service reports.

E. Warranty: Sample of special warranty.

F. Other Informational Submittals:

   1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

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

B. Include vendor contact information for service and warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be fully tested and documented to operate as a complete system.

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. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.

G. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

H. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

I. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

J. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

K. NOx Emission Standards. When installed and operated in accordance with manufacturer’s instructions, condensing boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.2; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, Rule 117.465

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 WARRANTY

A. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.

B. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.

C. All other components parts: Period of one year from substantial completion, to be free from defects in material and workmanship. Any units or parts which prove defective during the warranty period will be replaced with OEM parts and transportation

D. For Labor: One year(s) 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. AERCO International
2. Patterson-Kelley Co (Basis of Design).
3. Lochinvar Corporation.

2.2 CONDENSING BOILERS

A. Description: Boiler shall be natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation and discharge into a positive pressure vent. The minimum firing rate shall not exceed 50,000 BTU/HR input. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.

B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2” OD, with no less than 0.035” wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25” thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 6-inch diameter

C. Pressure Vessel: The pressure vessel shall have a maximum water volume of 16.25 gallons. The boiler water pressure drop shall not exceed 2.7 psig at 87 gpm. The boiler water connections

shall be flanged 150-pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases

D. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a 20-to-1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 for and the Texas Commission on Environmental Quality (TCEQ) as being compliant with Section 117.465. The burner shall be metal-fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

E. Minimum boiler efficiencies shall be as follows at a 20 degree delta-T:

EWT	100% Fire	50% Fire	5% Fire
160 °F	87%	87.3%	87.6%
120 °F	90.5%	91%	91.5%
80 °F	97.8%	98.1%	98.4%

F. The exhaust manifold shall be of corrosion resistant cast aluminum with a 6-inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

G. Blower. The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.

1. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Motors and Variable Frequency Drives."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0

H. Ignition: Ignition shall be via regulated staged spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

I. Adjustable Temperature Control: 50 deg F to 190 deg F.

J. Min/Max water flow: 25 – 150 gpm

K. Ventless Gas Train: Each boiler shall be provided with an integral main gas valve train. The main gas valve trains shall be factory assembled, piped, and wired. Each gas valve train shall include at least the following:

1. Manual shutoff valves
2. Safety shutoff valves. Valves equipped with dual solenoids that can independently energized for leak testing.
3. Air – Gas ratio control (maximum inlet pressure 14 in wc)
4. Low gas pressure switch (manual reset).
5. High gas pressure switch (manual reset).
6. Pressure test ports

L. Safety relief valve shall be provided in compliance with the ASME code. Contractor to pipe to acceptable drain

M. Provide separate inlet and outlet water temperature sensors capable of monitoring flow

N. Provide condensate neutralization kit to raise the pH of the condensate to a more neutral level before it is discharged to drain.
1. Kit shall include two .53 gallon capsules
2. Capacity- 4 gal.hr
3. Low profile design
4. All corrosion resistant material
5. Suitable for use on all types of natural gas and propane applications.
6. Include initial charge of neutralizing agent and ten refills.
7. Kit to be capable of being mounted in vertical or horizontal position.

2.3 VENTING

A. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230°F, positive pressure, condensing flue gas service. Refer to division 23 " Breeching, chimneys, and stacks" for further information.

B. The minimum exhaust vent duct size for each boiler is six-inch diameter

C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal duct connected between the boiler and the outdoors.

D. The minimum sealed combustion air duct size for each boiler is six-inch diameter.

E. Install per manufacturers written instructions.

2.4 ELECTRICAL

A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler

2.5 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC" and "Sequence of operations for HVAC controls."

B. The boiler control system shall be segregated into three components: “C-More” Control Panel, Power Box and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.

C. The control panel shall consist of six individual circuit boards using state-of-the-art surface-mount technology in a single enclosure. These circuit boards shall include:

1. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation
2. A CPU board housing all control functions
3. An electric low-water cutoff board with test and manual reset functions
4. A power supply board
5. An ignition /stepper board incorporating flame safeguard control
6. A connector board

Each board shall be individually field replaceable

D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.

E. The control panel hardware shall support both RS-232 and RS-485 remote communications.

F. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.

G. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:

1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
2. Setpoint Low Limit: Setpoint low limit allows for a selectable minimum operating temperature.
3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired

H. The boiler control system shall incorporate the following additional features for enhanced external system interface:

1. System start temperature feature
2. Pump delay timer
3. Auxiliary start delay timer
4. Auxiliary temperature sensor
5. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate

6. Remote interlock circuit
7. Delayed interlock circuit
8. Fault relay for remote fault alarm

I. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.

J. Boiler Management System (BMS): The Boiler Manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System Programmer to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. The BMS controller shall have the ability to operate up to 32 boilers per BMS panel.

The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The boiler controller shall control the boiler outlet header temperature within +4ºF to maintain the water supply temperature. BMS to provide the hot water supply temperature to be maintained by the boiler controller. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The boiler controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers. Boiler management system to energize associated pump when boiler is energized.

When set on Internal Setpoint Mode, temperature control setpoint on the boiler controller shall be fully field adjustable from 50ºF to 190ºF in operation. When set on Indoor/Outdoor Reset Mode, the boiler controller will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the boiler controller will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.

The boiler controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central boiler controller system and individual boilers shall be twisted pair low voltage wiring, with the boilers ‘daisy-chained’ for ease of installation

K. Provide with all necessary controls, all necessary programming sequences, and all safety interlocks. Each boiler control system shall be properly interlocked with all safeties.

L. Each boiler control system shall provide timed sequence pre-ignition air purge of boiler combustion chamber. The combustion airflow sensor shall monitor and prove the airflow purge.

M. Provide communication gateway controls interface to communicate with BACnet, Lonworks, and N2 and act as a MODBUS interface/translator between the BAS and either the RS-485 port of the “C-More” boiler control panel or the RS-232 port. Communications Gateway shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485. Non-volatile backup of all point mappings and programs shall

be internally provided as standard. Connection between Gateway and individual boilers shall be "daisy chain" with shielded, twisted-pair, low voltage wiring for ease of installation

2.6 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
   1. Each factory "packaged" boiler shall be hydrostatically tested. The boiler manufacturer shall perform a hydrostatic test in the presence of an inspector having a National Board Commission. The inspector shall certify a data report which shall be submitted to the engineer as evidence of ASME compliance.
   2. In addition to the ASME symbol, each boiler shall bear a National Board registration number.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Engineer 14 days in advance of testing.

D. Each factory "packaged" boiler shall be fire tested. The boiler manufacturer shall perform this fire test under simulated operating conditions, with the boiler attached to a working chimney system and with water circulating through the boiler. The manufacturer shall provide a fire test report, including fuel and air settings and combustion test results permanently affixed to the boiler.

E. All boilers associated with project shall be from one manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases.

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct bases to withstand, without damage to equipment, seismic force required by code.
3. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of boiler unless otherwise indicated or unless required for seismic anchor support.
4. Minimum Compressive Strength: 3000 psi at 28 days.
5. Install dowel rods to connect concrete base to concrete floor.
6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
7. Place and secure anchorage devices.
8. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

F. Connect condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."

I. Connect vent and breeching to full size of boiler outlet and inlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks" for venting materials.

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

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

3.4 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency
    b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

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

E. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.

    a. Test for full capacity.
    b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Engineer in advance of test dates.
8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 23 6313

AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, air-cooled refrigerant condensers for outdoor installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-cooled refrigerant condenser. Include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection. Provide wiring diagrams.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Field quality-control reports.

C. Startup service reports.

D. Warranty: Sample of special warranty

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be factory tested and documented to operate as a complete system.

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. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

G. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

H. Unit performance shall be rated in accordance with AHRI Standard 365, latest edition (U.S.A)

I. Unit shall be manufactured in a facility registered to ISO 9001 Manufacturing Quality Standard

J. Unit cabinet shall be capable of withstanding 500-hour salt-spray exposure per ASTM B117 (scribed specimen)

1.7 WARRANTY

A. Warranty Period:
   1. For Labor: One year from date of Substantial Completion
   2. For Parts: One years from date of Substantial Completion

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate location of refrigerant piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Carrier Corporation; Commercial HVAC Systems.
   2. McQuay International.
   3. YORK; a Johnson Controls company.

2.2 MANUFACTURED UNITS- ACCU-1

A. Description: Outdoor-mounted, air-cooled condensing unit with R-410A refrigerant suitable for on-the-ground installation. The unit shall consist of refrigeration circuit and rotary scroll compressors. Unit shall have air-cooled coils, propeller- type condenser fans, a control box, and shall discharge condenser air vertically upward as shown on certified drawings. Unit shall be used in refrigeration circuit with a central station air-handling unit or direct-expansion coils.

B. Refrigerant: R-410A.

C. Factory assembled, single-piece, air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressors, nitrogen holding charge, and special features required prior to field start-up.

D. Cabinet
1. Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.
2. Cabinet shall be capable of withstanding 500-hr salt spray test in accordance with ASTM (U.S.A.) B-117 standard.
3. Control box access panels shall be hinged for service access.
4. Lifting holes shall be provided to facilitate rigging

E. Fans
1. Condenser fans shall be direct-drive propeller type, discharging air vertically upward.
2. All condenser fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, class F insulation and internal, automatic-reset thermal overload protection or manual reset calibrated circuit breakers.
3. Shafts shall have inherent corrosion resistance.
4. Fan blades shall be statically and dynamically balanced.
5. Condenser-fan openings shall be equipped with PVC-coated steel wire safety guards

F. Compressor
1. Compressors shall be rotary scroll.
2. Operating oil charge and a crankcase heater control oil dilution.
3. Compressors shall be mounted on two rails having rubber in shear vibration isolators.
4. Staging of compressors shall provide unloading capability.
5. Digital compressor to provide incremental steps for tighter temperature control
6. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.

G. Refrigeration Components
1. Refrigeration circuit components shall include liquid line temperature relief device, pressure transducers, liquid line shutoff valve, suction shutoff valve, suction line accumulators, nitrogen holding charge, and compressor oil.
2. Long line length check valves are required for liquid line installation to prevent liquid migration during unit shutdown.
3. Units shall include one factory-installed suction line accumulator for each refrigerant circuit.

H. Electrical

1. Provide non fused disconnect switch installed within a NEMA 3R enclosure and motor starter.
2. All unit power wiring shall enter unit cabinet at a single location

I. Accessories
1. Sound reduction
   a. Provide low sound fan for sound reduction.
   b. Provide low sound compressor blankets for additional sound reduction
2. Security grilles/hail guards
   a. Units shall be supplied with factory-installed or field-installed louvered, sheet metal panels which securely fasten to the unit to provide condenser coil protection against hail and physical damage

J. Controls
1. Unit to be provided with factory installed stand-alone control system capable of BMS integration.
2. Unit controls shall include:
   a. Scrolling marquee display module shall be used for accessing condensing unit information, reading sensor values, and testing the condensing unit. The scrolling marquee display is a 4-key, 4-character, 16-segment LED (light-emitting diode) display. Eleven mode LEDs shall be located on the display as well as an Alarm Status LED. The display shows all of the control codes (with 60-character expandable clear language), plus set points, time of day, temperatures, pressures, and superheat.
   b. Unit control with standard pressure transducer, discharge pressure transducer and suction temperature thermistors.
   c. Current alarm list and alarm history list on display.
   d. Automatic compressor lead/lag control.
   e. Service run test capability.
   f. Compressor minimum run time (3 minutes) and minimum off time (3 minutes).
   g. Service diagnostic mode.
   h. Self-contained low voltage control circuit.
   i. Cycle condenser fans to maintain proper head pressure control.
   j. Capacity control with staging compressors.
   k. Optional digital scrolls to stage compressors and cycle digital compressor for maintaining desired leaving air temperature set point.
   l. Alarm relay output to indicate when unit is in alarm condition.
3. Minimum unit safety devices shall include:
   a. Solid-state compressor lockout to provide optional reset capability at the space thermostat if any of the following safety devices trip and shut off compressor.
   b. Compressor lockout protection for internal or external overload.
   c. Low pressure protection.
   d. High pressure protection (high pressure switch or internal).
   e. Compressor reverse rotation protection.
   f. Loss of charge protection.
   g. Low suction superheat protection.
   h. Short cycle protection.
   i. Suction and discharge pressure transducers.
   j. Circuit breakers or fuses for short circuit protection of compressors
4. BACnet Communication Option:

a. The BACnet Communication option shall provide factory-installed communication capability with a BACnet MS/TP network. Allows integration with i-Vu® Open control system or a BACnet building automation system.

b. BACnet Translator Control:

1) BACnet control shall be available as a field-installed accessory for all units to provide interface between unit and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485)

2.3 MANUFACTURED UNITS- ACCU-2 & 3

A. Description: Outdoor-mounted, air-cooled, split-system air conditioner unit suitable for ground or rooftop installation. Unit consists of a hermetic compressor, an air-cooled coil, propeller-type condenser fan, and a control box. Unit will discharge supply air upward as shown on contract drawings. Unit will be used in a refrigeration circuit to match up to a packaged fan coil or coil unit

B. Refrigerant: R-410A

C. Factory assembled, single piece, air-cooled air conditioner unit. Contained within the unit enclosure is all factory wiring, piping, controls, compressor, refrigerant charge Puron (R-410A), and special features required prior to field start-up.

D. Cabinet

1. Unit cabinet, including louvered coil guard, will be constructed of galvanized steel, bonderized, and coated with a powder coat paint

E. Fans

1. Condenser fan will be direct-drive forward-swept propeller type, discharging air upward.
2. Condenser fan motors will be totally enclosed, 1-phase type with class B insulation and permanently lubricated bearings. Shafts will be corrosion resistant
3. Fan blades will be statically and dynamically balanced
4. Condenser fan openings will be equipped with coated steel wire safety guards

F. Condenser Coil

1. Condenser coil will be air cooled
2. Condenser coil to be constructed of aluminum fins mechanically bonded to copper tubes which are then cleaned, dehydrated, and sealed.

G. Refrigerant components

1. Refrigeration circuit components to include liquid-line back-seating shutoff valve with sweat connections, vapor-line back-seating shutoff valve with sweat connections, system charge of Puron (R-410A) refrigerant, and compressor oil.
2. Unit to be equipped with high-pressure switch, low pressure switch and filter drier for refrigerant.

H. Electrical

1. Provide non fused disconnect switch installed within a NEMA 3R enclosure and motor starter.
2. All unit power wiring shall enter unit cabinet at a single location.

I. Controls
   1. Controls to be 24V single point connection.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Mount unit-mounted disconnect switches on exterior of unit in NEMA 3R enclosure.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate air-cooled refrigerant condensers according to ARI 460.

B. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.

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

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Equipment Mounting:

   1. Install air-cooled condenser refrigerant condensers on cast-in-place concrete equipment bases.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections:

1. Perform electrical test and 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. Complete manufacturer's starting checklist.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casing.
   b. Charger refrigerant system and verify refrigerant lines are properly charged
   c. Verify that access doors move freely and are weathertight.
   d. Clean units and inspect for construction debris.
   e. Verify that all bolts and screws are tight.
   f. Adjust vibration isolation and flexible connections.
   g. Verify that controls are connected and operational.

2. Lubricate bearings on fan motors.
3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
4. Adjust fan belts to proper alignment and tension.
5. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
6. Measure and record airflow and air temperature rise over coils.
7. Verify proper operation of capacity control device.
8. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
9. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION

SECTION 23 7313

INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 23 Section 230500 " Motors and Variable Frequency Drives

1.2 SUMMARY

A. Section Includes:

1. Variable-air-volume air-handling units.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.
e. Wiring diagrams

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Field quality-control reports.

C. Startup service reports.

D. Warranty: Sample of special warranty

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of start-up filters, one set of replacement filters, and 1 set of extra filters for each unit.
2. Gaskets: One set for each access door.
3. Fan Belts: One set for each air-handling unit fan.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be factory tested and documented to operate as a complete system.

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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

G. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

I. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

J. Comply with NFPA 70.

1.8 COORDINATION

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

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.9 WARRANTY

A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from substantial completion. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins. Any units or parts which prove defective during the warranty period will be replaced with OEM parts and transportation prepaid.

B. For Labor: One year(s) 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. Carrier
2. McQuay
3. York

2.2 GENERAL

A. AHUs shall be fully assembled and tested by the manufacturer in the factory in accordance with the arrangement shown on the drawings. Fans shall be tested and rated in accordance with AMCA Standard 210 or performance and in accordance with ANSI standards of testing for sounds power levels.

B. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field

rigging and final placement of unit. Unit manufacturer shall furnish unit with sufficient gasket and bolts for reassembly in the field.

C. The AHU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Engineer of Record. If a local representative cannot be provided, the manufacturer shall provide a factory representative.

2.3 AIR HANDLING UNIT AHU-1

A. DESCRIPTION: Horizontal 2-pipe, belt-driven, galvanized casing model unit for ducted installation, floor mounted, with full access to internal components. Unit shall be complete with water coils, refrigerant coil, fan(s), motor, belt drive, drain pan, mixing box, dampers, access doors, electrical components, and filter.

B. UNIT CASINGS
1. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit
2. All units shall be supplied with 14-gage or heavier, G-90 galvanized steel base rails. Bolton legs are NOT acceptable. Perimeter lifting lugs for overhead lifting shall be provided on each section. Slinging units in place of lifting lugs shall not be acceptable
3. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
4. Provide “no thru-metal” casing construction.
5. Casing panels (top, sides, and bottom) shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13
6. Exterior casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall the following exterior finishes as specified
   a. Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM B-117) for pre-painted steel and 125-hour marine level 1 prohesion test (ASTM G-85.A5) for pre-painted steel.
7. Interior casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall the following interior finishes as specified:
   a. Unpainted G-90 galvanized steel
8. Casing deflection shall not exceed a 1:200 ratio when subject to an internal pressure of ± 8-in. wg. Casing leakage rate shall be less than 1% at 8 in. wg of nominal unit airflow. Leakage rate shall be tested and documented on a routine basis on random production units. Optionally, factory witness leak testing and/or test reports shall be available
9. Access doors:
   a. Access doors shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13
   b. Thermal pane reinforced glass viewports shall be factory-installed on the door(s) of the section.
   c. Doors are complete with 304-stainless steel piano hinge and a minimum of two-lock type handles. All door seals are to have a replaceable bulb type, extruded gasket for a positive seal.

d. Provide an access door to each section- fan section, refrigerant coil, hot water coil section, filter section, and mixing box section.

10. Condensate drain pan:

a. Drain pans shall be insulated double-wall galvanized or stainless steel construction. The pan shall be sloped toward the drain connection. Drain pan shall have 11/2-in. MPT connection exiting through the hand side or opposite side of the casing as specified. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE Standard 62. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

C. FAN, DRIVE, AND MOTOR SECTION

1. Forward-curved fans shall have one double-width double-inlet (DWDI) fan wheel and scroll. They shall be constructed of galvanized steel with baked enamel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class II). Completed fan assembly shall be dynamically balanced in accordance with 1989 ARI Guideline G and ANSI S2.19- 1986 at design operating speed using contract drive and motor if ordered
2. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical
3. Fan assembly vibration shall not exceed 0.248 in. per second when mounted on active isolators. Vibration shall be measured in both vertical and horizontal directions at the specified fan operating speed using specified motor. Accelerometers shall be mounted on the motor near the bearing locations.
4. All fan sled components shall provide corrosion protection to pass 100-hour salt spray test per ASTM B-117
5. Motors- Refer to Division 23 Section 230500 " Motors and Variable Frequency Drives

a. Fan motor shall be mounted within the fan section casing on slide rails equipped with adjusting screws.

b. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members.

c. Motor to be premium efficiency, inverter duty, with Class F insulation.

6. Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base slide rail assembly with adjusting screws. The base assembly is isolated from the outer casing with factory-installed isolators. Units shall use 2-in. deflection spring isolators.
7. Provide fan with belt guard and inlet screen.
8. Bearings: Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L50) of 200,000 hours or optionally for an (L50) of 500,000 hours. Provide extend grease fittings to exterior of unit.
9. Shafts: Fan shafts shall be solid steel, turned, ground, polished and coated with a rust inhibitor
10. Belt: Drive shall be designed for a minimum 1.2 service factor as standard with a 1.5 service factor. Drives shall be fixed pitch. All drives shall be factory mounted, with sheaves aligned and belts properly tensioned
11. Manufacturer shall submit first through eighth octave sound power for fan discharge and casing radiated sound.

D. COIL SECTIONS

1. All coil performance shall be certified in accordance with AHRI Standard 410. All water coils shall be tested at 450 psig air pressure.
2. Direct expansion coils shall be designed and tested in accordance with ASHRAE/ANSI 15 Safety Code for Mechanical Refrigeration (latest edition)
3. Refrigerant coils shall have minimum 1/2-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.025 inches.
4. Water coils shall have minimum 5/8-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.035 inches.
5. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of mill galvanized steel.
6. Hydronic
   a. Headers shall be constructed of steel with red brass nipple connections. Headers shall have drain and vent connections accessible from the exterior of the unit
   b. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200 F.
7. Refrigerant
   a. Headers shall be constructed of copper with brazed joints.
   b. Replaceable nozzle, brass refrigerant distributors and seamless copper distribution tubes are supplied to ensure uniform flow.
   c. Submittals must include a DX coil and condensing unit cross plot to show that the coil and condensing unit capacity match at the rated design conditions

E. CAPACITIES AND CHARACTERISTICS
1. Refer to schedule on drawings.

F. AIR FILTRATION SECTION
1. General Requirements for Air Filtration Section:
   a. Comply with NFPA 90A.
   b. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
2. Pre filter: 2 inch Angle MERV 8 filter sections shall accept either 2-in. or 4-in. filters of standard sizes, arranged in a horizontal V formation.
3. Post final filter: 4 inch MERV 13 Flat filter sections shall accept either 2-in. or 4-in. filters. Sections shall include side access slide rails
4. Magnehelic Gages:
   a. Housing shall be constructed of a die cast aluminum case and bezel with acrylic cover. Exterior finish shall be coated gray to withstand 168 hr salt spray corrosion test.
   b. Accuracy shall be ±2% of full scale throughout range at 70 F.
   c. Pressure limits shall be –20 in. Hg to 15 psig.
   d. Overpressure relief plugs shall open at approximately 25 psi.
   e. Temperature limits shall be 20 to 140 F.
   f. Diameter of dial face shall be 4 in.
   g. Process connections shall be 1/8-in. female NPT duplicate high and low pressure taps — one pair side and one pair back.

G. DAMPERS
1. Mixing boxes shall have opposed blade outside-air and return-air dampers

2. Damper blades shall be constructed of galvanized steel with a double-skin airfoil design, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 2 cfm/ft^2 at 1 in. wg (0.25 kPa) differential pressure.

H. ELECTRICAL

1. General Requirements for Electrical:

   a. The air handling unit manufacturer shall factory prewire the fan motor, internal lights and switch, receptacles, where specified, for a complete prewired package. The entire air handling unit as assembled at the factory shall be either UL or ETL labeled.

   b. Type THHN/THWN insulation, rated 600volts.

   c. All wiring shall be in accordance with NEC and the entire unit shall be either ETL or UL Certified.

   d. The AHU manufacturer shall furnish and install a single Variable Frequency Drive , NEMA 1, with hand-off-auto selector switch and lockable disconnect switch to control all fans. Contractor to coordinate location of VFD with equipment manufacturer and layout within room and maintain proper clearances.

2. The air handling unit manufacturer shall factory prewire an industrial quality vapor tight marine light fixture in the fan section and with an external switch near the access door and shall prewire a 120V ground fault circuit interrupting convenience receptacle inside the fan section. Terminate all wring in junction boxes mounted on the exterior of the unit. Wiring arrangement to accommodate 120V connection to the GFI.

3. Conduit:
   a. Electrical Metal Tubing (EMT) manufactured in accordance with ANSI standards. One half-inch minimum permitted size.

   b. Liquid tight Flexible Metallic Conduit: Use for connections to motors and other vibrating equipment. Maximum length to be 36 inches for up to 1 inch size and 60 inches for conduit larger than 1 inch
4. Unit shall include interlocking fan door disconnect switch and relay, factory wired, to disable the fan when the fan door is opened.
5. Variable Frequency Fan Drive Controllers
   a. Basis of Design
      1) ABB
   b. Factory-mounted variable frequency drives (VFDs) shall be wired to factory-supplied motors to accommodate single point power to the VFD.
   c. Factory-supplied VFDs are programmed and started up from the factory and qualify the VFD, through ABB, for a 24-month warranty from date of commissioning or 30 months from date of sale, whichever occurs first.
   d. The VFD parameters are programmed into the controller and removable keypad. In the event that the VFD fails and needs replacement, the program can then be uploaded to the replacement VFD via the original keypad
   e. The VFD package as specified herein shall be enclosed in a UL Listed type enclosure, exceeding NEMA enclosure design criteria (enclosures with only

NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO 9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and –35% nominal voltage as a minimum

1) Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 50 C (32 to 122 F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD's that can only operate at 40 C intermittently (average during a 24 hour period) and therefore, must be oversized. VFDs shall be capable of operating at altitude 0 to 3300 feet above sea level and less than 95% humidity, non-condensing. All circuit boards shall have conformal coating
2) Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable. Type 1 enclosures with only NEMA rating are not acceptable (must be UL Type 1).

f. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs

g. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting

h. There shall be a built-in timeclock in the VFD keypad. The clock shall have a battery back-up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/ stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the timeclock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings

i. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.

j. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.

k. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start)

l. The VFD shall have the ability to automatically restart after an overcurrent, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable

m. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/ UL table 430.250 for 4-pole motors

n. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add an AC line reactor

o. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFDs with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate

p. The VFD shall include a coordinated AC transient surge protection system consisting of 4 to 120 joule rated MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

q. The VFD shall provide a programmable loss-of-load (broken belt/broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and/or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition

r. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure/jam condition causing motor overload

s. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and/or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control

t. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and/or over the serial communication bus.

u. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

v. All VFDs to have the following adjustments:

   1) Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed

   2) Two (2) PID set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are

typically used for night setback, switching between summer and winter set points, etc

3) There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
4) Two (2) programmable analog inputs shall accept current or voltage signals.
5) Two (2) programmable analog outputs (0 to 20 mA or 4 to 20 mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
6) Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.
7) Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
8) Run permissive circuit: There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, timeclock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (endswitch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety input status shall also be transmitted over the serial communications bus.
9) The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 to 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications).
10) Seven (7) programmable preset speeds.
11) Two independently adjustable accelerate and decelerate ramps with 1 to 1800 seconds adjustable time ramps.
12) The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
13) The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
14) The VFD shall include password protection against parameter changes

w. The keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alphanumeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
   1) Start-up assistant
   2) Parameter assistants
   3) PID assistant
   4) Reference assistant
   5) I/O assistant
   6) Serial communications assistant
   7) Option module assistant
   8) Panel display assistant
   9) Low noise set-up assistant
   10) Maintenance assistant
   11) Troubleshooting assistant
   12) Drive optimizer assistants

x. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
   1) Output Frequency
   2) Motor Speed (RPM, %, or Engineering units)
   3) Motor Current
   4) Motor Torque
   5) Motor Power (kW)
   6) DC Bus Voltage
   7) Output Voltage

y. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from –500 Hz (reverse) to 500 Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.

z. Serial Communications:
   1) The VFD shall have an EIA-485 port as standard. Coordinate with building control provider for required protocol. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.
   2) If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
   3) Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock

and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

aa. EMI/RFI filters: All VFDs shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.

bb. Operational Functions:

1) The drive shall contain two separate acceleration/ deceleration times with auto tuning for optimum setting (0.1 to 6000 seconds) with factory programmed to match the fan load and prevent nuisance overcurrent fault trips.
2) The drive shall be equipped with both local/ remote and manual/auto keys on touchpad.
3) The drive shall be equipped with a quick setup key.
4) The drive shall contain 15 preset speeds, which can be activated from the keypad, terminal inputs, and host computer.
5) The drive shall have the capability of storable special custom user setting.
6) The drive shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
7) The drive shall have adjustable soft stall (10% to 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation factory programmed for each motor's characteristics.
8) The drive shall be capable of performing a time base pattern run using 4 groups of 8 patterns each using the 15 preset speed values for a maximum of 32 different patterns.
9) The drive shall have adjustable UL listed electronic overload protection (10% to 100%) factory programmed to match each motor's FLA/RLA ratings.
10) The drive shall have a custom programmable volt/hertz pattern

cc. Protective Features

1) The drive shall be rated for 200,000 AIC (ampere interrupting capacity). The use of input fuses to achieve this rating shall not be acceptable.
2) The drive shall have external fault input.
3) The drive shall be capable of resetting faults remotely and locally.
4) The drive shall be programmable to alert the following alarms
   a) Over torque alarm.
   b) Inverter overload pre-alarm.
   c) Motor overload pre-alarm.
   d) Braking resistor overload pre-alarm.
   e) Inverter overheat pre-alarm.
   f) Undercurrent alarm.
   g) Overcurrent pre-alarm.
   h) Communication error alarm.
   i) Cumulative timer alarm.

j) Executing retry

5) The drive shall identify and display the following faults:
   a) Overcurrent during acceleration trip.
   b) Overcurrent during deceleration trip.
   c) Overcurrent during normal run trip.
   d) Overcurrent on the DC Bus during acceleration trip.
   e) Overcurrent on the DC Bus during deceleration trip.
   f) Overcurrent on the DC Bus during normal run trip.
   g) Load end overcurrent trip detected at start-up (output terminals, motor wiring, etc.).
   h) U-phase short circuit trip detected at start-up.
   i) V-phase short circuit trip detected at start-up.
   j) W-phase short circuit trip detected at start-up.
   k) Overvoltage during acceleration trip.
   l) Overvoltage during deceleration trip.
   m) Overvoltage during normal (constant speed) run trip.
   n) Inverter overloaded trip.
   o) Motor overloaded trip.
   p) Inverter overheat trip.
   q) Emergency off trip message.
   r) EEPROM failure during write cycle.
   s) EEPROM abnormality during initial reading.
   t) RAM error.
   u) ROM error.
   v) CPU error.
   w) Communication interruption error.
   x) Gate array error.
   y) Output current detection circuit error.
   z) Option PCB error trip.
   aa) Low operating current trip.
   bb) Main circuit under voltage trip.
   cc) Over torque trip.
   dd) Software detected earth fault trip.
   ee) Hardware detected earth fault trip.
   ff) Inverter type form mismatch error.
   gg) EEPROM type form mismatch error

dd. Monitor Functions
   1) The drive digital display shall be capable of displaying the following: Frequency, percent current, current amps, percent voltage I/O, voltage in volts I/O, RPM, GPM, I/O watts, torque, and input reference signal, kWh.
   2) The drive shall have 320 programmable parameters which can be changed while the drive is operating.
   3) The drive’s 353 parameters shall be adjustable from the 8-key touchpad or computer link.
   4) The drive’s 8-key touchpad shall be NEMA 12 rated.
   5) The drive’s keypad shall be capable of being extended 15 ft from the drive.
   6) The drive shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).
   7) The drive shall have 2 programmable analog outputs programmable to 17 choices.

8) The drive shall have one programmable relay output programmable to 67 choices.
9) The drive shall have 8 programmable digital inputs programmable to 54 choices.
10) The drive shall have a pulse train out-put proportional to frequency (48, 96, 360 times frequency).
11) The drive shall have an elapsed time meter

I. WARRANTY
1. Provide 5 year parts only warranty associated with all components of the air handling unit. Warranty period to begin at start-up or 6 months from the state of shipment, whichever occurs first.
2. The VFD shall be provided with a 2 years parts and labor warranty

2.4 AIR HANDLING UNIT AHU-2

A. DESCRIPTION: Horizontal 2-pipe, belt-driven, galvanized casing model unit for ducted installation, suspended, with full access to internal components. Unit shall be complete with water coils, refrigerant coil, fan(s), motor, belt drive, drain pan, mixing box, dampers, and filter.

B. UNIT CASINGS
1. Construction shall be double wall heavy-gage galvanized steel, lined with one-in. thick fiberglass thermal/acoustical insulation. Knockouts shall be provided for hanging the horizontal unit, that will accept 3/8-in. threaded rod at the top and bottom of all unit corners. Supply and return duct connections shall be 1 in. long. Removable side panels shall be provided for access to the fan/motor assembly. Access panels shall be easily removable without tools on horizontal unit.
2. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
3. Provide “no thru-metal” casing construction.
4. Exterior casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall the following exterior finishes as specified
   a. Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM B-117) for pre-painted steel and 125-hour marine level 1 prohesion test (ASTM G-85.A5) for pre-painted steel.
5. Interior casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall the following interior finishes as specified:
   a. Unpainted G-90 galvanized steel
6. Mixing box
   a. Bottom and rear inlet
   b. Provide with dampers and linkage kit
   c. Construction to match unit construction
7. Condensate drain pan:
   a. A double-sloped drain pan shall be constructed of stainless steel, extending under the full length and width of the coil(s) with a 3/4-in. male nominal pipe thread stainless steel drain connection and 1/2-in. male NPT stainless secondary drain connection (cap when not required). The outside surface of the drain pan shall be insulated with 1/8-in. closed cell insulation. Drain pan is removable from cabinet from same end as coil connections for ease of cleaning.

C. FAN, DRIVE, AND MOTOR SECTION

1. Belt-driven, double-width fan wheels shall have forward- curved blades and be statically and dynamically balanced.
2. Fan drive shall consist of variable-pitch motor pulley, fixed-diameter blower sheave with keyed shaft, and V-belt.
3. Fan drive shall be designed for 120% of rated fan horsepower.
4. Fans and scrolls shall be of galvanized steel.
5. Bearings are ball bearings, permanently lubricated and sealed for life. Bearings are isolated from the blower housing by rubber mounts set into heavy gage metal support system.
6. The blower housing shall be isolated from the cabinet and motor
7. Motors- Refer to Division 23 Section 230500 " Motors and Variable Frequency Drives
    a. Fan motors shall be open, drip-proof, single-speed, single or 3 phase, suitable for continuous duty at 104 F (40 C).
    b. Motors to be continuous duty rated. Motors to be resilient mounted, NEMA frame motors. Motors to be factory wired to unit junction or control box. Motor bearings to be permanently lubricated. Motors to be mounted on an adjustable base for belt tensioning and alignment. The motor and drive to be installed on the same end as the coil connection for ease of service.
    c. Motor to be premium efficiency, inverter duty, with Class F insulation

D. COIL SECTIONS

1. All coil performance shall be certified in accordance with AHRI Standard 410. All water coils shall be tested at 450 psig air pressure.
2. Direct expansion coils shall be designed and tested in accordance with ASHRAE/ANSI 15 Safety Code for Mechanical Refrigeration (latest edition)
3. Refrigerant coils shall have minimum 1/2-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.025 inches.
4. Water coils shall have 1/2-in. copper tubes, aluminum fins bonded to the tubes by mechanical expansion and have a working pressure of 250 psig at 200 F. Each coil shall have a manual air vent and sweat connections for copper tubes
5. Water coils shall have minimum 5/8-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.035 inches.
6. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of mill galvanized steel.
7. Hydronic
    a. Headers shall be constructed of steel with red brass nipple connections. Headers shall have drain and vent connections accessible from the exterior of the unit
    b. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200 F.
8. Refrigerant
    a. Headers shall be constructed of copper with brazed joints.
    b. Replaceable nozzle, brass refrigerant distributors and seamless copper distribution tubes are supplied to ensure uniform flow.
    c. Submittals must include a DX coil and condensing unit cross plot to show that the coil and condensing unit capacity match at the rated design conditions

E. CAPACITIES AND CHARACTERISTICS

1. Refer to schedule on drawings.

F. AIR FILTRATION SECTION

1. General Requirements for Air Filtration Section:
   a. Comply with NFPA 90A.
   b. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
2. Filter: 2 inch MERV 8 flat filter

G. DAMPERS

1. Mixing boxes shall have opposed blade outside-air and return-air dampers
2. Damper blades shall be constructed of galvanized steel with a double-skin airfoil design, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 2 cfm/ft^2 at 1 in. wg (0.25 kPa) differential pressure.

H. ELECTRICAL

1. General Requirements for Electrical:

   a. The air handling unit manufacturer shall factory prewire the fan motor for a complete prewired package. The entire air handling unit as assembled at the factory shall be either UL or ETL labeled.

   b. Type THHN/THWN insulation, rated 600volts.

   c. All wiring shall be in accordance with NEC and the entire unit shall be either ETL or UL Certified.

2. Conduit:
   a. Electrical Metal Tubing (EMT) manufactured in accordance with ANSI standards. One half-inch minimum permitted size.

   b. Liquid tight Flexible Metallic Conduit: Use for connections to motors and other vibrating equipment. Maximum length to be 36 inches for up to 1 inch size and 60 inches for conduit larger than 1 inch

3. Unit shall be equipped with interlocking door-disconnect switch with lock-out tag-out compatibility, touch-type fusing, 24-v transformer, motor contactor and terminal strip for connection to field provided controller.

I. Warranty Period:

1. For Labor: One year(s) from date of Substantial Completion
2. For Parts: Two years from date of Substantial Completion

2.5 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

D. All factory-built air handling units shall be tested in accordance with the latest applicable industry standards as specified herein and be either UL or ETL listed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases or suspended.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units with flexible connectors.

D. Connect condensate drain pans. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping". Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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, section assembly, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Leak Test: If provided in multiple sections and factory test of unit did not meet leakage rate requirements, unit to be retested in the field after final installation with all sections assembled and sealed to meet required leakage rates.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Install new, clean filters.
9. Verify air handling unit assembly is per manufacturer guidelines.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel for a minimum of 2-hours to adjust, operate, and maintain air-handling units.

END OF SECTION

SECTION 23 7314

OUTDOOR CENTRAL-STATION HEAT RECOVERY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 23 Section 230500 " Motors and Variable Frequency Drives

1.2 SUMMARY

A. Section Includes:

1. 100% outside air, constant volume, heat recovery units

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.
e. Wiring diagrams

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Field quality-control reports.

C. Startup service reports.

D. Warranty: Sample of special warranty

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of start-up filters, one set of replacement filters, and 1 set of extra filters for each unit.
2. Gaskets: One set for each access door.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be factory tested and documented to operate as a complete system.

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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

G. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

I. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

J. Comply with NFPA 70.

1.8 COORDINATION

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

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.9 WARRANTY

1. Provide 5 year parts only warranty associated with all components of the air handling unit. Warranty to period to begin at start-up or 6 months from the state of shipment, whichever occurs first.
2. The VFD shall be provided with a 2 years parts and labor warranty

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Zone International
2. Carrier
3. Ingenia

2.2 GENERAL

A. Exhaust unit shall be fully assembled and tested by the manufacturer in the factory in accordance with the arrangement shown on the drawings. Fans shall be tested and rated in accordance with AMCA Standard 210 or performance and in accordance with ANSI standards of testing for sounds power levels.

B. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit. Unit manufacturer shall furnish unit with sufficient gasket and bolts for reassembly in the field.

C. The exhaust unit manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet

manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local representative cannot be provided, the manufacturer shall provide a factory representative.

2.3 HEAT RECOVERY UNIT

A. GENERAL

1. Provide factory-fabricated custom air handling units to meet the performance requirements as shown on the equipment schedule. Unless otherwise noted, each unit shall be complete with 2” double wall septum casing design – 100% No Thru Metal in roof, walls and doors. The Return Air/Exhaust Air Stream shall be explosion resistant construction.

B. UNIT CASINGS

1. General Fabrication Requirements for Casings:
   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets.
   c. Sealing: Seal all joints with water-resistant sealant.
   d. Factory Finish for Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   e. Casing Coating: Baked enamel, color selected by architect.
   f. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2. Base Construction:
   a. The unit base shall be 6” deep x 6.5#/ft. steel channel, continuously welded at all joints and designed to support the entire assembly. A minimum of (2) lifting lugs per side shall be removable, and attached to the structural steel base with Grade 9 bolts attached to welded nuts on the inside of the 6” channel base. As applicable, the unit shall be shipped in multiple shipping splits to facilitate transportation and handling in accordance with the drawing. Additional lugs & bracing shall be provided as necessary to facilitate special rigging & installation requirements. All sections to be drawn together shall be provided with gasketing and extra gasketing shall be shipped with the exhaust unit. Individual sections shall be drawn together at the lifting lugs.

3. Casing Wall Construction:
   a. Unit Casing shall be constructed of properly sized 2” double wall septum panels fabricated of 16 gauge G-90 galvanized steel exterior with 20 gauge G-90 galvanized steel interior liner. Each roof and wall panel shall be reinforced and supported with 16-gauge G-90 galvanized steel “C” or “Z” channels on 16” centers to form a rugged assembly for all components. All sections are to have solid liners. Provide “no thru-metal” casing construction. The casing panels are to be insulated with single layer of 2”- 3.0# inner density. All insulation is to be encapsulated between the inner and outer skin or each panel and the inner panel that is perforated shall have the FSK vapor seal.

b. All casing panels shall be in full accordance with NFPA 90A and UL 181. Full service access panels are required in each section for easy service. All service doors are to be full size, complete with a stainless steel piano hinge and a minimum of two-vent lock type handles. All door seals are to be bulb type, extruded vinyl

4. Casing Roof Construction:
   a. The unit roof shall be constructed of galvanized 2" deep double wall panels fabricated of 16-gauge galvanized exterior and with a solid 20-gauge G-90 galvanized steel interior liner. Each roof and wall panel shall be reinforced and supported with 16-gauge G-90 galvanized steel "C" channels on 24" centers in both directions to form a rugged unitized assembly for all components. The unit roof panels shall be completely caulked and sealed. All roof panels shall be insulated with 2"- 3# inner density encapsulated between the inner and outer skin, in full accordance with NFPA 90A and UL 181. The Exhaust AHU shall have perimeter gutter and minimum ¼" sloped roof. Gutters shall be provided around unit perimeter. Gutter to be provided down side of unit and drain onto ground. Extend gutter down side and terminate 1" above the pad.

5. Casing Floor Construction:
   a. The unit floor shall be constructed of galvanized 4" deep double wall panels fabricated of 3/16" aluminum checkerboard floor inside the air unit with a solid 20-gauge underside liner. Each floor and wall panel shall be reinforced and supported with 16-gauge G-90 galvanized steel "C" channels on 16" centers in both directions to form a rugged unitized assembly for all components. The unit floor shall be insulated with 4"- 4# inner density encapsulated between the inner and outer skin, in full accordance with NFPA 90A and UL 181. The top panel shall extend to the outermost edge of the unit base and the wall panels must sit on top of the floor; a 16-gauge G-90 galvanized steel "Z" member shall be welded to the tread plate floor at the unit perimeter to accept all wall panels. All floor panels are to be stitch welded with a minimum of 1" welds on 12" centers; after welding the floor must be completely caulked and sealed. The 20-gauge under floor covering must be stitch welded with a minimum of 1" welds on 12" centers then caulked and sealed. The 20-gauge under floor covering must be stitch welded with a minimum of 1" welds on 12" centers then caulked and sealed to prevent the ingress of unwanted moisture entering through the air unit floor. A recessed area within the floor must be prepared to accept the 304-stainless steel drain pan as further described below.

6. Casing Deflection shall not exceed 1/250 of an inch at mid-span when operating at 1.5 times the rated pressure or a maximum of 8".

7. Leakage- Unit shall be tested for cabinet leakage at 1.15 times design TSP and shall indicate no greater than 1.0% leakage, using AMCA leak testing machine with calibrated orifices. Negative sections to be tested under negative pressure and positive sections tested under positive pressure.

8. External Finish

a. The unit shall be painted with primer and finished with a baked on enamel passing 500-hour salt spray test (ASTM B-117) for pre-painted steel and 125-hour marine level 1 prohesion test (ASTM G-85.A5) for pre-painted steel. Color to be selected by architect.

9. Access Doors:
   a. The unit access doors frames are to be formed as part of the unit casing on access doors that swing inward; access doors that swing outward shall be complete with frames to match the air unit casing. Sections that are under a negative pressure shall have doors that swing outward and sections with a positive pressure are to have doors that swing inward. All access doors are to be a minimum of 16" wide and maximum height up to a 60" frame. Doors are complete with a continuous 304-stainless steel piano hinge and a minimum of two-vent lock type handles. All door seals are to have a replaceable bulb type, extruded gasket for a positive seal. The access door shall be constructed and insulated identical to that specified for the wall construction. Viewports shall be provided in all doors. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
   b. Provide access doors on both sides of the unit within each section of the unit.

10. Service Light: 100-W vaporproof fixture with switched weather tight junction box located outside and adjacent to door.

11. Provide an air tight recessed housing control cabinet and door in the side of the unit. Door to be flush with the exterior unit wall.

12. Provide recessed housing and door to accommodate the VFD installation within the side of the unit. Door to be flush with the exterior unit wall. Cabinet to be vented b the air stream. Both the supply and return vfd housing to be located within either the outside air or supply air streams. Do not install in the exhaust air stream.

13. Provide outside air and exhaust air hood with birdscreen- provide multiple hoods to accommodate multiple openings. One hood per opening.

C. FAN, DRIVE, AND MOTOR SECTION
1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   a. Fans to be SISW Direct Drive Quiet Plenum type
   b. Fans shall be direct drive plenum fan with an airfoil backward curved aluminum wheel with aluminum inlet cone. Each fan assembly shall be encapsulated in a fan cube with perforated liner. No fan spring isolators shall be provided. Fans shall be Class II.
   c. Each fan shall be supplied with piezometer ring to measure airflow.
   d. Each motor shall be provided with an individual thermal overload. One (1) VFD shall be provided for the complete fan array.
   e. Backdraft dampers shall be provided for each fan – Ruskin BD2/A1 or equivalent.
   f. Each Fan array shall consist of 2" Double wall with perforated liner for sound attenuation purposes. Neoprene pad shall be provided under each fan array for vibration isolation.
   g. Premium efficiency, inverter duty rated motors for direct driven fans shall be factory mounted directly on the fan support framework, internal to the air unit.

Each adjustable motor base shall be mounted to a base rigidly supported to the fan structural framework. Refer “Electrical” section below for additional requirements

h. Motors- Refer to Division 23 Section 230500 " Motors and Variable Frequency Drives
   1) Supply Fan Motors shall be NENA design B with calls F insulation.
   2) Return Fan- Motors shall be explosion proof rated for Class 1, Group D
   3) Motor voltage and horsepower shall match that specified on the drawings. Motors shall have a minimum service factor of 1.15. Motors shall be high efficient type meeting the minimum standards of EPACT with TEFC casing and suitable for use with a VF Drive. Brake horsepower of the fan shall not exceed 90% of the horsepower rating of the motor. The motor shall be provided with heavy-duty steel NEMA type adjustable base. All motors equal to and over 7.5HP shall be furnished with a shaft grounding ring.

i. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
   1) Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   2) Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

D. CAPACITIES AND CHARACTERISTICS
   1. Refer to schedule and details on drawings.

E. DAMPERS
   1. Provide the following dampers
      a. Outside air face and bypass damper
      b. Outside air damper
      c. Exhaust air damper
   2. Aluminum backdraft type relief dampers:
      a. Frame shall be minimum 14-gauge formed aluminum or stainless steel channel frame, reinforced at corners structurally equivalent to 14-gage U-channel. Blades shall be minimum 14-gauge aluminum, parallel. Jamb seals are 304-stainless steel compression type. Axles are minimum 1/2-inch diameter solid plated steel, mechanically attached to each blade. Outside air damper shall be designed at a velocity not greater than 950’/minute

F. INDIRECT GAS FIRED HEAT
   1. The basis of design is Heatco. Gas Fired heaters shall be rack mounted with natural gas fuel type and have an 80% minimum thermal efficiency and incorporating listed gas-fired duct furnaces.
   2. The gas-fired furnaces shall have a tubular heat exchanger constructed of 304L stainless steel .047” min wall thickness produced to ASTM A249. Heat exchanger design shall be suitable to withstand 3.0” w.c. total ESP.
   3. Furnaces shall incorporate a direct spark ignition control module that shall provide:
      a. 100% safety shut-off
      b. A 15 second pre-purge period prior to trial for ignition
      c. High energy direct spark ignition of main burners
      d. Electronic flame supervision incorporating a .8 second flame failure response time
      e. Up to 2 additional ignition retrials preceded by an interpurge period

f. A minimum of 30 second post-purge
g. Automatic reset after one hour to initiate additional ignition trials if lockout occurs during heat call
h. An alarm capable contact
i. An LED indicator light to provide a flash code to identify the operating condition of the control

4. Voltage shall be 120/1/60. All electrical components shall be listed by ETL, UL or CSA.
5. Gas supply pressure to the gas valve inlet shall be 5.0” to 13.5” for natural gas
6. A circulating air flow switch and manual reset high temp limit control shall be shipped loose and installed by the AHU manufacturer.
7. Turn Down ratio shall be either 40:1 for the 4000 MBH output heaters and 20:1 for the 2500 MBH output heaters.
8. Provide Flue pipe extension and cap.

G. FIXED PLATE AIR TO AIR CROSSFLOW HEAT EXCHANGER

1. Corrugated aluminum air-to-air crossflow exchanger. Plates shall be fabricated with the Heatex corrugation pattern, increasing turbulence and heat transfer without creating stagnation points. Flat plate laminar flow exchanger designs are unacceptable.
2. Plate corners shall be sealed with MS polymer silicone free sealant and rated for air temperatures up to 190 degrees F
3. Connecting plate edges shall be folded on automated manufacturing equipment. Adhesive in plate folds shall limit leakage to .1% at 1.6” WC differential pressure.
4. Exchanger assembly shall consist of corrugated plate exchanger core, extruded aluminum corner profiles and aluzinc steel endplate framing. Complete assembly shall form a rigid, stable unit. Exchangers which require rib plate separators or other support for structural reinforcement are unacceptable.
5. Aluminum corner profiles shall be hollow to accept mounting screws.
6. Endplates shall be manufactured with aluzinc coated steel.
7. Exchanger shall withstand 7” WC maximum differential pressure without permanent deformation
8. Drain Pans for Heat Plate Exchanger
   a. The Drain Pan is to be of the double pan construction type of type 304-stainless steel and recessed into the floor as described in the floor construction. The cavity surrounding the drain pan shall be filled with insulation on all sides and the drain pan shall be sealed into the floor cavity. The pan assembly is to be continuously welded and shall be sloped in all directions a minimum of 1/8” per foot. A 304-stainless steel drain connection (minimum 1 ¼” MPT) shall be located on one side at the lowest point. The drain pan shall be designed to drain-dry when the air unit is not in operation. Provide the required P-trap to properly remove condensate and allow the drain pan to function as a drain-dry design.
   b. Shim the air handling unit channel base with shear-flex pads as required to level the unit or to provide a slope of the drain pan toward the drain point of 1/16” per 1’-0” if required by the unit design to cause the drain pan to drain completely dry on unit shutdown

H. FILTERS

1. Filter Holding Tracks
   a. Filter holding frames shall be of heavy-duty construction designed for industrial applications. Tracks shall be serviced from the side and a pull tray shall be provided to remove the filters. Holding frames may be required in some applications and shall be accessed from upstream. Holding frames shall be

constructed of no less than 18-gauge galvanized steel, equipped with clips to hold the filters firmly on place. Gaskets are required for a positive seal on high efficient filters. The depth of high efficiency frames shall be no less than 2.75" in direction of airflow in order to provide adequate bearing surface for built-up filter banks. Filter clips shall be capable of being installed without the use of special tools, bolts or nuts. Filter holding frames shall be of the universal type in that they shall accommodate all standard size filters.

b. Filters shall be U.L. Class 2 when tested in accordance with U.L. Standard 900. Pre-filters shall be 2" Deep and shall have an average efficiency of MERV 8. The filters shall be designed in such a manner as to prevent air bypass.

I. ELECTRICAL

1. General Requirements for Electrical:

a. The unit manufacturer shall factory prewire the fan motor, internal lights and switch, receptacles, where specified, for a complete prewired package. The entire exhaust unit as assembled at the factory shall be either UL or ETL labeled.

b. Type THHN/THWN insulation, rated 600volts.

c. All wiring shall be in accordance with NEC and the entire unit shall be either ETL or UL Certified.

d. The unit manufacturer shall furnish and install a single Variable Frequency Drive, NEMA 3R, with hand-off-auto selector switch and lockable disconnect switch to control all fans. VFD to be provided with a transformer and electric resistant heater to maintain temperature above minimum rating of drive.

1) VFD to be factory wired to junction boxes at each VFD. Provide conduit and wiring between VFD junction boxes to accommodate single point power to one junction box.

2. The unit manufacturer shall factory prewire an industrial quality vapor tight marine light fixture and with an external weather tight switch in all sections and shall prewire a 120V ground fault circuit interrupting convenience receptacle inside the supply fan section. Terminate all wring in weather tight junction boxes mounted on the exterior of the unit. Wiring arrangement to accommodate single 120V connection to the GFI.

3. Conduit:

a. Electrical Metal Tubing (EMT) manufactured in accordance with ANSI standards. One half-inch minimum permitted size.

b. Liquid tight Flexible Metallic Conduit: Use for connections to motors and other vibrating equipment. Maximum length to be 36 inches for up to 1 inch size and 60 inches for conduit larger than 1 inch

4. Variable Frequency Fan Drive Controllers:

a. Basis of design:

1) ABB

b. Variable speed drive shall be provided by the exhaust unit manufacturer. Variable speed drives shall be mounted, installed and wired to the fan motor by the air unit manufacturer to accommodate single point power connection to VFD.

c. Variable speed drive shall be mounted internal to the unit installed within a 16 gauge galvanized steel enclosure with a gasketed hinged access door to match unit construction. VFD controls to be accessed from exterior of the unit utilizing a weather tight door.

d. All Variable Frequency Drives shall be factory pre-set and tested prior to shipment and the manufacturer shall provide a minimum two-year warranty.

e. Exhaust unit manufacturer shall certify in writing that the fan motors and VFD operate together as a system, fully compatible and without excessive noise or vibration.

f. The 1 through 100 HP, 208V AC VFD shall be a pulse width modulated (PWM) design that operates directly from three phase, 208V AC ±10%, 60 hertz utility power. The VFD shall generate a sine coded, adjustable voltage/frequency three phase output for complete speed control of any squirrel cage induction motor. The VFD shall maintain a one hundred and ten (110%) percent current overload capability for sixty (60) seconds with automatic stall prevention and voltage boost to prevent nuisance tripping during load or line side transient conditions. Provide an input line reactor or tuned line filter, adjusted as required, to minimize any electrical distortion back into the building electrical power supply system to within IEEE Standard 519-1992 limits. The VFD shall maintain a power factor of not less than 0.95 throughout its speed range.

g. Control protocol: BACnet IP

h. VFD to be provided with remote reset capability.

i. The VFD shall have the following basic design:
   1) Converter: Converter shall consist of a modularized diode rectifier and capacitor assembly, which will first convert, then filter and maintain a fixed DC voltage source from the fixed voltage and frequency input.
   2) Inverter: Inverter uses IGBT semiconductors with a minimum rating of 1100V AC on 208V AC controls to invert the converter generator fixed DC voltage into a sine coded pulse width modulated output.
   3) Control Logic: Consists of a single printed circuit board and incorporates an eight (8) bit or larger, microcomputer central processing unit to control all inverter, converter, base drive and external interface functions.
   4) Enclosure: A single plenum rated NEMA 12 enclosure to house the drive and all accessories.
   5) All internal wiring within the variable speed drive shall be copper.

j. The VFD shall have, as a minimum, the following design features as standard:
   1) Sine coded, pulse width modulated output.
   2) Eight (8) bit or larger, microcomputer control logic.
   3) Maximum and minimum speed adjustment capability.
   4) Controlled speed range of 20:1 or greater.

5) Overload capability of ten (10%) percent for sixty (60) seconds. Control System for remote start-stop and speed control signal.
6) Process follower 4-20mA or 1-10V DC input.
7) Minimum of three (3) selectable output frequency ranges.
8) Minimum fifteen (15) selectable volts/hertz patterns.

k. Touch pad operator controls with at least four (4) segment digital frequency/speedometer or digital readout displaying at a minimum: output frequency, output current and status.

Output frequency.
Output current.
Status.

1) Incoming electrical power disconnect/circuit breaker with through door handle.
2) Torque or current limiting circuit.
3) Coast or ramp to stop.
4) Adjustable acceleration and deceleration.
5) Fault indicators.
6) Proportion Integral (PI) Set point Controller.
7) Analog Outputs: Two (2) 0 to 20 mA signals.
8) Programmable Analog Inputs: Two (2) voltage and one (1) current.
9) Programmable Digital Inputs: At least five (5).

l. The VFD shall have, as a minimum, the following protective features:
1) Ground fault protection.
2) Electronic thermal motor overload or current limit control.
3) Current limited stall prevention during acceleration, deceleration and run conditions.
4) Automatic restart after momentary power loss or momentary over voltage. No restart into ground fault.
5) Controls for start into a rotating motor.
6) Anti-windmill protection.
7) Fault indicators shall indicate the following fault conditions.
8) Over current/overload..
9) Over voltage.
10) Over temperature.
11) Control function error.
12) DC bus discharge indicator.
13) Current limiting dc bus fuse.
14) Isolated operator controls.
15) Phase-to-phase short circuit protection.
16) Heat sink over temperature protection.
17) The VFD shall have the following adjustments available:
a) Acceleration - 0.2 to 1800 seconds or 0.1 to 300 seconds.
b) Deceleration - 0.2 to 1800 seconds or 0.1 to 300 seconds.
c) Volts/hertz adjustments.
d) Minimum frequency.
e) Maximum frequency.
f) Carrier frequency.
g) Torque limit.

h) Input line reactors or tuned line filters shall be provided by the inverter manufacturer to limit interference from the line to the drive and to limit any electrical distortion back to the building electrical power supply system in accordance with the recommendations of IEEE Standard 519-1992 to less than three (3%) percent. The filter or reactor assembly shall be mounted integral with the VFD or in a separate enclosure adjacent to the VFD if the manufacturer provides the field wiring.

i) A signal isolator shall be provided to isolate the control signal to and from the inverter drive.

18) The VFD shall be designed to operate within the following environmental and service conditions:

a) Ambient service temperature - 5ºF to º140F.
b) Ambient storage temperature - 5ºF to º140F.
c) Humidity – non-condensing to ninety (90%) percent.
d) Altitude to 3300'.
e) Service factor - 1.0.
f) Input voltage - three (3) phase, 460V AC ±10%.
g) Input frequency - 50/60 hertz ±2 hertz.

m. The VFD shall be subject to the following parameters and tests:

1) All integrated circuits (TTL) and all components used for circuit board construction shall be tested to an acceptance criteria of 0.5% AQL (Accepted Quality Level).
2) In circuit testing of all printed circuit boards shall be conducted to insure proper mounting and correct value of all components.
3) All printed circuit boards shall be burned in for at least twenty-four (24) hours, at a minimum of 70ºC and temperature cycled.
4) Final printed circuit board assemblies shall be functionally tested via computerized test equipment where all tests and acceptance criteria are preprogrammed and test results are stored as detailed quality assurance data. The Engineer and Owner may witness the factory tests. The Division 15 Subcontractor shall give the Engineer and Owner at least two (2) weeks written notice prior to start of the factory test.
5) All fully assembled controls shall be combine tested for performance and functionality at the manufacturer's factory with fully loaded VAV rated induction motors. The combined test data shall then be analyzed to insure adherence to quality assurance specifications.

n. The VFD shall be designed and built to the following standards:

1) ETL and/or UL
2) NEMA - ICS-3-303
3) IEEE STD 444 (ANSI C34.3)
4) IEEE STD 519-1992

o. The VFD shall be provided with the following features:

1) One (1) door interlocked main power input disconnect or circuit breaker to provide positive shutdown of all input power to the drive.

2) The complete circuit breaker input disconnect, overload relay package and line reactor or tuned line filter shall be mounted in the inverter cabinet or may be installed in a separate enclosure adjacent to the inverter.

3) Capacitor shall be sized based on the VFD design and the two (2) second ride through as required. The capacitor shall provide assistance to maintain the dc bus voltage for a two (2) second momentary power loss or furnish automatic restart capability, which allows restart into a rotating motor in both forward and reverse rotation.

4) The Owner and/or Engineer may observe the exhaust units for this Project under manufacture at the factory prior to shipment, if he so desires. Notify the Owner and Engineer in writing at three (3) weeks prior to the first air handing unit production date.

2.4 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. All factory-built exhaust units shall be tested in accordance with the latest applicable industry standards as specified herein and be either UL or ETL listed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install air-handling units on equipment pad.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect duct to air-handling units with a hard duct connection.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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, section assembly, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Leak Test: If factory test of unit did not meet leakage rate requirements, unit to be retested in the field after final installation with all sections assembled and sealed to meet required leakage rates.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that dampers open and close.
7. Install new, clean filters.
8. Verify air handling unit assembly is per manufacturer guidelines.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel for a minimum of 2-hours to adjust, operate, and maintain air-handling units.

END OF SECTION

SECTION 23 8126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Field quality-control reports.

C. Startup service reports.

D. Warranty: Sample of special warranty

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of start-up filters, one set of replacement filters, and 1 set of extra filters for each unit

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be factory tested and documented to operate as a complete system

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. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

    a. For Compressor: Five year(s) from date of Substantial Completion.
    b. For Parts: One year(s) from date of Substantial Completion.
    c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. YORK; a Johnson Controls company.

2.2 INDOOR UNITS (IACU-1 & 2)

A. Wall mounted Evaporator-fan components:
1. General
    a. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be provided with integral wall mounting bracket and mounting hardware.
2. Cabinet
    a. Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance
3. Fan
    a. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
    b. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.
4. Coil
    a. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wetability. A drip pan under the coil shall have two drain connections for hose attachment, on either the left or right-hand side, to remove condensate. Condensate pan shall have internal trap.
5. Motors
    a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
6. Controls
    a. The unit shall have stand-alone controls.

b. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. the temperature control range shall be from 62_F to 84_F.

c. User interface with the unit shall be accomplished through a wired controller with user interface.

d. The unit shall have the following functions as a minimum:

1) An automatic restart after power failure at the same operating conditions as at failure.

2) A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.

3) Temperature-sensing controls shall sense return air temperature.

4) Indoor coil freeze protection.

5) Automatic vertical air sweep control to provide on or off activation of air sweep louvers. Automatic horizontal air sweep is available on sizes 030 and 036.

6) Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.

7) Fan-only operation to provide room air circulation when no cooling is required.

8) Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.

9) Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.

e. Provide control wiring and conduit between the indoor unit, outdoor unit, and control unit.

7. Filters

a. Unit shall have filter track with factory-supplied cleanable filters

8. Electrical.

a. Two way low voltage communication between outdoor and indoor unit.

b. All power and control wiring must be installed per NEC and all local electrical codes.

c. Provide single point power to IACU.

9. Additional features

a. Condensate pump

1) The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. A liquid level sensor in the reservoir shall stop cooling operation if the liquid level in the reservoir is unacceptable.

2.3 INDOOR UNITS (IACU-3)

A. Ceiling mounted 2’x2’ heat pump

1. General

a. Indoor, direct-expansion, low profile, heat pump, in-ceiling fan coil. Unit shall be complete with a coil, fan, fan motor, piping connectors, condensate pump, and hanging brackets.

2. Unit cabinet
   a. Cabinet shall be constructed of zinc-coated steel. Fully insulated discharge and inlet grilles shall be attractively styled, high-impact non- metallic material.
   b. The inlet grille shall have hinges and can be opened to obtain access to the cleanable filters, indoor fan motor and control box. Fresh air to be introduced in two ways:
      1) Use an auxiliary fresh air intake flange to condition the outside air before it is introduced into the space.
      2) Use a fresh air inlet and filter chamber to introduce unconditioned outside into the space.
3. Fans
   a. Fan shall be centrifugal direct-drive blower type with air intake in the center of the unit and discharge at the perimeter. Automatic, motor-driven vertical air sweep shall be provided standard. Automatic motor-driven louvers shall be provided standard and shall be adjustable for 2, 3 or 4-way discharge.
   b. Air sweep operation shall provide three user selectable modes.
4. Coil
   a. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wet-ability. A drip pan under the coil shall have a factory installed condensate pump and drain connection for hose attachment to remove condensate. A replaceable element in the condensate disposal system provides antibacterial protection
5. Motors
   a. Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be inverter controlled variable speed.
6. Controls
   a. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, run self diagnostics, provide save mode and self cleaning. The temperature control range shall be from 64°F to 84°F.
   b. User interface with the unit shall be accomplished through an accessory wired remote control. The wired remote control shall be capable of running system diagnostics (displays operating conditions of the system)
   c. The unit shall have the following functions
      1) Selectable automatic restart, after power failure the system will restart at the same operating conditions as before the failure.
      2) A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
      3) Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
      4) Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
      5) Automatic air sweep control to provide multiple operating modes of the air sweep louvers.
      6) Dehumidification mode shall provide increased latent removal through total system modulation.
      7) Fan-only operation to provide room air circulation when no cooling is required.

8) Diagnostics shall provide continuous checks of unit operation and warn of malfunctions. Error messages shall be displayed at the unit or the remote control.
9) Fan speed control shall be user-selectable: high, medium, low, or microprocessor determined based on the differential between the room temperature and the set point during all modes of operations.
10) Automatic changeover control shall include an adjustable dead band to prevent rapid mode cycling between heating and cooling.
11) Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
12) Cold blow prevention in heating.
13) Adjustable compensation for air stratification in heating

d. Provide control wiring and conduit between the indoor unit, outdoor unit, and control unit

7. Filters
   a. Unit shall have factory-supplied cleanable filters, with adjustable filter cleaning reminder on wired remote control
8. Electrical.
   a. Outdoor unit provides power to the indoor fan coil
   b. Two way low voltage communication between outdoor and indoor unit.
   c. All power and control wiring must be installed per NEC and all local electrical codes

2.4 OUTDOOR UNITS (ACCU-4 & 5)

A. Units shall consist of a scroll compressor, an air-cooled coil, propeller-type blow-through outdoor fan, reversing valve (HP), accumulator, Accurator metering device(s), and control box. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the compressor

B. Cabinet
   1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish on inside and outside.
   2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
   3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
   4. Compressor compartment shall be isolated to allow performing diagnostics while the system is running.

C. Fans
   1. Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall blow air through the outdoor coil.
   2. Outdoor fan motors shall be totally-enclosed, single phase motors with class B insulation and permanently-lubricated bearings. Motor shall be protected by internal thermal overload protection.
   3. Shaft shall have inherent corrosion resistance.
   4. Fan blades shall be metallic and shall be statically and dynamically balanced.
   5. Outdoor fan openings shall be equipped with PVC coated metal protective grille over fan

D. Compressor
1. Compressor shall be fully hermetic scroll type.
2. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current.
3. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
4. Compressor assembly shall be installed on rubber vibration isolators

E. Outdoor coil
1. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.

F. Refrigerant components
1. Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, reversing valve.

G. Controls
1. The unit shall have stand-alone controls
2. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
   a. A time delay control sequence is provided standard through the fan coil board.
   b. Automatic outdoor-fan motor protection
3. Safeties
   a. Diagnostics provided by matched indoor unit.
   b. Compressor motor current and temperature overload protection.
   c. Outdoor fan failure protection (High Pressure Switch).
   d. Low pressure protection.
   e. Fusible plug to vent refrigerant safely in case of a fire

H. Electrical.
1. Two way low voltage communication between outdoor and indoor unit.
2. All power and control wiring must be installed per NEC and all local electrical codes.
3. Provide NEMA 3R disconnect and single point power to ACCU.

I. Additional features
1. Low-Ambient Kit: Control shall regulate fan-motor cycles in response to saturated condensing temperature of the unit. The control shall be capable of maintaining a condensing temperature of 100_F ± 10_F with outdoor temperatures to -20_F. Installation of kit shall not require changing the outdoor fan motor.
2. Wind baffle

2.5 OUTDOOR UNITS (ACCU-6)

A. General
1. Factory assembled, single piece, air-cooled, heat pump, outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the compressor.

B. Cabinet
1. Unit cabinet shall be constructed of pre-coated steel, finished on both inside and outside.

2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
3. Compressor shall be isolated and have an acoustic wrap to assure quiet operation.
4. Compressor compartment shall be isolated to allow performing diagnostics while the system is running.

C. Fans
1. Outdoor fan(s) shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall draw air through the outdoor coil.
2. Outdoor fan motor(s) shall be totally-enclosed, inverter driven with permanently-lubricated ball bearings. Motor shall be protected by internal thermal overload protection.
3. Shaft shall have inherent corrosion resistance.
4. Fan blades shall be non metallic and shall be statically and dynamically balanced.
5. Outdoor fan openings shall be equipped with non metallic protective grille over fan.

D. Compressor
1. Compressor shall be fully hermetic, inverter driven, twin cylinder rotary type.
2. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature operation.
3. Motor shall be suitable for operation in an R-410A refrigerant atmosphere.
4. Compressor assembly shall be installed on rubber vibration isolators.

E. Outdoor coil
1. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed

F. Refrigeration Components
1. Refrigerant circuit components shall include brass liquid line and suction line service valves, service gage port connections with Schrader type fittings, accumulator and reversing valve.

G. Controls
1. Operating controls and safeties shall be factory selected, assembled, and tested.
2. The unit shall have the following functions as a minimum:
   a. A time delay sequence is provided in the inverter control.
   b. Automatic outdoor-fan motor speed control
   c. Safeties
      1) Diagnostics provided by inverter control.
      2) Compressor motor current and temperature protection.
      3) Outdoor fan failure protection (High Pressure Switch).
      4) Low pressure protection.
      5) Fusible plug to vent refrigerant safely in case of a fire.

H. Electrical.
1. Outdoor unit provides power to the indoor fan coil
2. Two way low voltage communication between outdoor and indoor unit.
3. All power and control wiring must be installed per NEC and all local electrical codes.

I. Additional features
1. User activated forced defrost cycle
2. User activated refrigerant pump down cycle

3. Wind baffle to allow cooling operation down to 5 °F

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Anchor unit to equipment stand.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

E. Provide all low voltage wiring in conduit between indoor, outdoor units, and remote thermostats.

3.2 CONNECTIONS

A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

B. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.3 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.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casing.
   b. Charger refrigerant system and verify refrigerant lines are properly charged
   c. Verify that access doors move freely and are weathertight.
   d. Clean units and inspect for construction debris.
   e. Verify that all bolts and screws are tight.
   f. Adjust vibration isolation and flexible connections.
   g. Verify that controls are connected and operational.

2. Lubricate bearings on fan motors.
3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
4. Adjust fan belts to proper alignment and tension.
5. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
6. Measure and record airflow and air temperature rise over coils.
7. Verify proper operation of capacity control device.
8. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
9. After startup and performance test, lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers

END OF SECTION

SECTION 23 8216.11

HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydronic heating coils

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.
3. Include factory test reports.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Warranty: Sample of special warranty

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

B. The product shall be provided by a single manufacturer.

C. The manufacturer authorized representative shall be factory trained and certified personnel providing service, startup, and quality control field labor for the project from their local office.

D. All components shall be fully tested and documented to operate as a complete system.

1.6 CLOSEOUT SUBMITTALS

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

B. Include vendor contact information for service and warranty

1.7 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Parts: Period of one year from substantial completion, to be free from defects in material and workmanship. Any units or parts which prove defective during the warranty period will be replaced with OEM parts and transportation prepaid.

B. For Labor: One year(s) from date of Substantial Completion

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SFI coils
2. Aerofin.
3. McQuay

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Maximum Working-Pressure/Temperature Ratings: 350 psig, 300 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, 5/8 inch, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.008 inch thick die-formed plate typ. Collars to be full-drawn to provide maximum contact with tubes. Tubes to be mechanically expanded into the fins.

G. Headers: Extra heavy seamless copper tubing with intruded type holes to provide a strong brazing joint for the coil tubes.

H. Frames: 16 gauge galvanized-steel channel frame, for flanged mounting.

I. Drainable

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

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

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

D. Coils to be factory tested. Provide test and inspection report.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

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

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230900 "Instrumentation and Control for HVAC," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

END OF SECTION

SECTION 23 8219

FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Ducted fan coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include rated capacities, operating characteristics, and furnished specialties and accessories. Provide wiring diagrams.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Fan Coil Unit Filters: One set of start-up filters, one set of replacement filters, and 1 set of extra filters for each unit.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.9 WARRANTY

A. Warranty Period:
   1. For Labor: One year(s) from date of Substantial Completion
   2. For Parts: Two years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED FAN COIL UNITS

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

   1. Carrier Corporation; a UTC company.
   2. McQuay International; a member of Daikin Group.
   3. YORK; by Johnson Controls, Inc.

B. Description: Horizontal, 2-pipe fan coil unit for ducted installations. Factory assembled, horizontal or vertical blow-thru ducted fan coil unit. Unit shall be complete with water coil(s), refrigerant coil, fan(s), motor(s), drain pan, and all required wiring, piping, controls and special features.

C. Casing:

1. Outside panels shall be galvanized steel, lined on the inside with 1/2-in. thick foil faced fiberglass insulation and a 1 in. long collar for supply duct connection
2. The drain pan shall be constructed of 18-gage stainless steel extending the entire length and width of coil(s) and pitched for drainage. The inside surface of the drain pan shall be coated with closed-cell, fire retardant foam. An extension drain pan shall be provided for installation at the jobsite under the factory-furnished electric water valves
   a. Drain pan shall include a second drain connection located above the main drain connection to act as an indicator that the main drain is plugged

D. Return air plenum:

1. Unit shall have a factory-installed, 18-gage galvanized steel plenum section and 1-in. throwaway filter. The plenum shall be either bottom or rear return, lined with 1/2-in. thick fiberglass insulation and include a removable panel to provide access to the fan/motor assembly.
   a. Filters: 1” pleated MERV 8

E. Fans

1. Direct-driven, double-width fan wheels shall have forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel.

F. Coils

1. Heating coils shall have 1/2-in. copper tubes and aluminum fins; Coil fins are mechanical bonded to tube joints. The copper tubes comply with the ASTM B-75. The fin thickness is 0.0045-in. and tube thickness is 0.016- inch. All coils to be tested with air under water and are suitable for design working pressures of 250 psig at 220 F. Burst tested at 300 psig.
2. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.

G. Motors

1. 115V/1 phase ECM V2 variable speed

H. Controls

1. Factory-installed 24-v transformer and relay board for use, with 24-v controls by others

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

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

3.2 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with spring hangers.

D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.

    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

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

3.6 DEMONSTRATION

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

END OF SECTION

SECTION 23 8236

FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydronic, finned-tube radiation heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 HOT-WATER BASEBOARD RADIATION HEATERS- ARCHITECTURAL

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

1. Zehnder Rittling
2. Modine
3. Sterling Hydronics; a Mestek company.

B. Units shall be manufactured in accordance with conformance to ISO 9001:2000 standards

C. Performance Ratings: Rate baseboard radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

D. Heating Elements:

1. Copper heating elements shall consist of aluminum fins not less than .016 thick with integral fin collars, which space the fins and provide good tube to fin surface contact, permanently bonded to copper seamless drawn tubing by mechanically expanding the copper tubing, to ensure durability and eliminate noise from loose fins, while assuring performance at specified catalog ratings. The ends of the tube shall be finished OD (male) on one end and finished ID (female swaged) on the other end as to allow the use of standard domestic copper fittings. Elements to be provided from 1 ft to 12 ft lengths in 6" increments

E. Enclosure

1. Enclosures shall be of the size and style as shown on the plans. Enclosures shall be manufactured from 16-gauge cold rolled steel. All enclosures shall be reinforced with a (minimum of two) gussets welded at ends of each enclosure style. The joining of enclosure shall be accomplished by use of internal joggle joiners providing added rigidity and alignment with adjoining enclosures. No sheet metal screws or other fastening devices shall be visible. Enclosures to be provided from 1ft to 8 ft lengths in 6" increments.

2. The upper portion of the enclosure will be secured in a hinge type manner by use of a full length roll formed mounting channel or full back panel, while the lower portion of the enclosure will be secured to steel snap expansion brackets by use of a positive locking, bottom mounting clip using fasteners thus preventing removal without tools.

3. Grille shall have a clear anodized finish with a 15-degree deflection and be a “pencil proof” design.

F. Finish

1. All enclosures and accessories shall be degreased and chemically phosphatized before application of a durable, attractive electrostatic epoxy powder coating. Color to be selected from manufacturer standard color chart.

G. Accessories

1. Access doors shall be provided in 12" long access panels or in the enclosure where noted on plans. The doors shall have an overall size 6" x 6" as standard (size may vary as space becomes limited). Access doors should be installed where flow control or shut off valves are located. Doors shall be hinged at the top and use a slotted fastener to operate. Recessed security Allen head operators shall be used in secure areas as indicated. Security damper must be operated by use of a hex key.

2. Provide enclosure dampers. Damper blades shall be fabricated from 18-gauge galvanized material painted to match enclosure color. Threaded damper screw and trunion shall provide positive operation of blade to provide variable heat output. Solid plastic damper

knobs attached to damper screw shall operate damper. Recessed security Allen head operators shall be used in secure areas as indicated.

3. Mounting channel shall be die formed from 23-gauge galvannealed steel and the full back panel from 20-gauge galvannealed steel. For rigidity, the top projection of the mounting channel or full back plate shall position the enclosure away from the wall so as to allow for installation or removal of enclosure without damage to wall. A urethane gasket shall be provided with the unit to form air seal at wall.

4. Snap expansion and second row brackets shall be die formed from 16-gauge galvanneal for rigidity. Snap expansion brackets shall incorporate a positive locking, bottom mounting clip for fastening the enclosure, as well as supporting one row of finned tube. Brackets shall be self-gauging, allowing for a single measurement installation. All brackets must provide for lengthwise movement of elements during expansion and contraction as well as aligning elements to prevent contact with walls or enclosure.

5. Provide trim pieces between ends of enclosures and walls on wall-to-wall installations (inside corners, outside corners, wall trims, end caps and removable access panels). Trims may be overlapping or butt-type depending on the application. All trims will be manufactured from 18-gauge cold rolled steel.

2.2 HOT-WATER BASEBOARD RADIATION HEATERS

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

1. Zehnder Rittling
2. Modine
3. Sterling Hydronics; a Mestek company.

B. Units shall be manufactured in accordance with conformance to ISO 9001:2000 standards

C. Performance Ratings: Rate baseboard radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

D. Heating Elements:

1. Copper heating elements shall consist of aluminum fins not less than .016 thick with integral fin collars, which space the fins and provide good tube to fin surface contact, permanently bonded to copper seamless drawn tubing by mechanically expanding the copper tubing, to ensure durability and eliminate noise from loose fins, while assuring performance at specified catalog ratings. The ends of the tube shall be finished OD (male) on one end and finished ID (female swaged) on the other end as to allow the use of standard domestic copper fittings. Elements to be provided from 1 ft to 12 ft lengths in 6" increments

E. Enclosure

1. Enclosures shall be of the size and style as shown on the plans. Enclosures shall be manufactured from 16-gauge cold rolled steel. All enclosures shall be reinforced with a

(minimum of two) gussets welded at ends of each enclosure style. The joining of enclosure shall be accomplished by use of internal joggle joiners providing added rigidity and alignment with adjoining enclosures. No sheet metal screws or other fastening devices shall be visible. Enclosures to be provided from 1ft to 8 ft lengths in 6" increments.

2. The upper portion of the enclosure will be secured in a hinge type manner by use of a full length roll formed mounting channel or full back panel, while the lower portion of the enclosure will be secured to steel snap expansion brackets by use of a positive locking, bottom mounting clip using fasteners thus preventing removal without tools.

F. Finish

1. All enclosures and accessories shall be degreased and chemically phosphatized before application of a durable, attractive electrostatic epoxy powder coating. Color to be selected from manufacturer standard color chart.

G. Accessories

1. Access doors shall be provided in 12" long access panels or in the enclosure where noted on plans. The doors shall have an overall size 6" x 6" as standard (size may vary as space becomes limited). Access doors should be installed where flow control or shut off valves are located. Doors shall be hinged at the top and use a slotted fastener to operate. Recessed security Allen head operators shall be used in secure areas as indicated. Security damper must be operated by use of a hex key.

2. Provide enclosure dampers. Damper blades shall be fabricated from 18-gauge galvanized material painted to match enclosure color. Threaded damper screw and trunion shall provide positive operation of blade to provide variable heat output. Solid plastic damper knobs attached to damper screw shall operate damper. Recessed security Allen head operators shall be used in secure areas as indicated.

3. Mounting channel shall be die formed from 23-gauge galvannealed steel and the full back panel from 20-gauge galvannealed steel. For rigidity, the top projection of the mounting channel or full back plate shall position the enclosure away from the wall so as to allow for installation or removal of enclosure without damage to wall. A urethane gasket shall be provided with the unit to form air seal at wall.

4. Snap expansion and second row brackets shall be die formed from 16-gauge galvanneal for rigidity. Snap expansion brackets shall incorporate a positive locking, bottom mounting clip for fastening the enclosure, as well as supporting one row of finned tube. Brackets shall be self-gauging, allowing for a single measurement installation. All brackets must provide for lengthwise movement of elements during expansion and contraction as well as aligning elements to prevent contact with walls or enclosure.

5. Provide trim pieces between ends of enclosures and walls on wall-to-wall installations (inside corners, outside corners, wall trims, end caps and removable access panels). Trims may be overlapping or butt-type depending on the application. All trims will be manufactured from 18-gauge cold rolled steel

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties”. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

   1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Section 230900 "Instrumentation and Control for HVAC."

D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

C. Prepare test and inspection reports.

END OF SECTION

SECTION 23 8239

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and hot-water coils.
2. Propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated. Provide wiring diagrams.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters and unit heaters to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Motor failure.
   b. Coil leak.

2. Warranty Period: Two years from date of substantial completion.
3. Warranty Period (Motor Only): Two years from date of substantial completion.
4. Warranty Period (Coil Only): Two years from date of substantial completion

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

1.9 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Equipment manufacturer shall be ISO 9001:2008 certified.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

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

1. Zehnder Rittling

2. McQuay International

3. Carrier Corporation

B. Description: Factory-packaged and -tested units rated according to ASHRAE 33 and UL 1995.

C. Insulation: ¼” thick, elastomeric closed cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 and UL 723.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
4. Polyethylene or fiberglass insulation is not acceptable.

D. Chassis: 20 gauge galvannealed steel where exposed to moisture.

E. Cabinet: 14 gauge steel factory baked epoxy powder coating in manufacturer's standard paint color as selected by Architect.
1. Horizontal Units:
a. The front panel shall be hinged, 14 gauge steel providing full swing through 90° including removable safety chain(s) to prevent the panel from swinging fully open accidentally. Includes baked epoxy powder coated aluminum double deflection discharge grille, channel-formed edges and ¼-turn allen-head cam fasteners.
2. End pockets shall be no less than 8” in width, located on both sides of the unit.

F. Filters: Minimum arresta nce according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. 1” Glass Fiber Throwaway: 80 percent arrestance and MERV 4.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.083 inch (2.1 mm), rated for a minimum working pressure of 300 psig (2067 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Minimum copper tube thickness shall be 0.016”. Minimum fin thickness shall be 0.0045”. Lanced fins shall not be acceptable. Coils shall be circuited for counter flow to maximize unit efficiency. Coil casing shall be fabricated from galvanized steel. Include manual air vent and drain valve.

H. Fan and Motor Board: Constructed from 18 gauge galvannealed steel.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. galvanized-steel wheels and fan scrolls.
2. Motor: Permanently lubricated, multispeed PSC; resiliently mounted on motor board. Shaded pole motors are not acceptable. Single speed motors are not acceptable. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

I. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

J. DDC Terminal Controller: Factory mounted.
1. Interface relay for scheduled operation to cycle fan on and off

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

1. Provide combination motor/starter disconnect switch.

2.2 PROPELLER UNIT HEATERS

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

1. Zehnder Rittling

2. McQuay International

3. Carrier Corporation

B. Description: An assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: All units shall have panels fabricated of not less than 18 gauge cold rolled steel.
1. Horizontal Units:
   a. Casing consists of top/back and side halves. Both halves are joined on top and back with hex head screws.
   b. Top casing is furnished with threaded hanger connections for suspension of unit.
   c. Fan venturi is die-formed on back half.
   d. Units shall be equipped with horizontal, individually adjustable louvers (RH).
   e. Vertical louvers for four-way air control shall be included.
2. Vertical Units:
   a. Casing includes top and bottom pieces joined by corners and additional hardware.
   b. Top casing is furnished with threaded hanger connections for suspension of unit
   c. Provide a one-way louver to provide specific air throw pattern

F. Cabinet Finish: All painted cabinet exterior panels shall be finished with a standard textured gray epoxy powder coat paint.

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

H. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

I. Hot-Water: Designed for hot water heating system.
1. Coils shall have ½” nominal diameter seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and integral collar of the aluminum fin.
2. Minimum copper tube thickness shall be 0.028”.

3. Fins shall be die-formed and have a high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.
4. Minimum fin thickness shall be 0.010”.
5. Lanced fins shall not be acceptable.
6. Fins are continuous across width and depth of coil and are vertically oriented to resist collection of dirt and foreign particles.
7. Coils are of non-ferrous construction and serpentine design or incorporate brazed steel header tubes.
8. All coils shall be tested at 275 PSIG air pressure under water, and rated for a maximum 220 PSIG water or 150 PSIG steam and 375°F.
9. Coils have CRN pressure vessel certification for Ontario and Quebec provinces.

J. Fan: Propeller type with non-conducting, spark-proof aluminum blade wheel with steel hub directly mounted on motor shaft in the fan venturi.

K. Fan Guard: Shall be finger-proof, constructed of welded steel rod and finished with a standard black epoxy powder coat paint. Units mounted below 8 feet from the floor must be equipped with an OSHA fan guard to meet ETL and OSHA requirements.

L. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated, two-speed, permanent split capacitor, totally enclosed with automatic reset integral thermal overload protection, designed to handle up to 104°F maximum constant ambient temperature.

2. Motors within the wash bay and chassis wash
   a. Provide explosion proof motors with an enclosure designed and constructed to withstand an explosion of a specified gas or vapor which may occur within the motor and to prevent the ignition of this gas or vapor surrounding the unit. Explosion proof motor is suitable for Class I, Div I&II, Groups C&D and Class II, Div I&II, Groups F&G. All explosion proof motors to be shelf mounted.

M. DDC Terminal Controller: Factory mounted.
1. Interface relay for scheduled operation to cycle fan on and off

N. Electrical Connection: Factory wire motors and controls for a single electrical connection.

1. Provide combination motor/starter disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and connections to verify actual locations before unit heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers.

E. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers.

F. Install new filters in each cabinet unit heater within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Comply with safety requirements in UL 1995.

D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and automatic flow balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

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

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

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

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

DIVISION 26
ELECTRICAL

SECTION 26 0500

COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS – *Not Used*

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials must be approved for specific use.

END OF SECTION

SECTION 26 0513

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.

C. Qualification Data: For Installer.

D. Material Certificates: For each cable and accessory type, signed by manufacturers.

E. Source quality-control test reports.

F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Source Limitations: Obtain cables and accessories 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 C2 and NFPA 70.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than two months in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cables:
   a. Kerite Co. (The); Hubbell Incorporated.
   b. Okonite Company (The).
   c. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:
   a. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
   b. RTE Components; Cooper Power Systems, Inc.

2.2 CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Crosslinked polyethylene.

G. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 15 kV.
2. Insulation Thickness: 100 percent insulation level.

H. Shielding: Copper tape, helically applied over semiconducting insulation shield.

I. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

J. Cable Jacket: ethylene-propylene rubber (EPR) based, thermosetting compound, moisture and sunlight resistant.

2.3 SPLICE KITS

A. No splicing of cable is allowed.

2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; with stress-relief shield terminator and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.7 FAULT INDICATORS

A. Indicators: Manually reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

E. Install "buried-cable" warning tape 12 inches (305 mm) above cables.

F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

G. Install cable splices at pull points and elsewhere as indicated; use standard kits.

H. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: Three.
3. Standoff Insulator: Three.

I. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

J. Seal around cables passing through fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

K. Install fault indicators on each phase where indicated.

L. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

M. Identify cables according to Division 16 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, perform tests as listed below in “TEST PROCEDURE”.

B. Remove and replace malfunctioning units and retest as specified above.

3.3 TEST PROCEDURE

A. The objective of the testing is to assure that the cable installation is operational within industry and manufacturer’s tolerance, is installed in accordance with Contract documents and is suitable for energizing.

B. The testing procedures shall comply with the INETA standard and IEEE 400. Upon satisfactory completion of tests, attach a label to tested components.

C. Tests shall include high-potential test, for 15 minutes at 35KV, of cable and accessories and such test and examinations as required to achieve specified objectives. Where new cables are spliced to existing cables, the high-potential tests shall be performed on the new cable prior to splicing. After test results for new cables are approved and splice is made, and insulation resistance test and continuity test shall be performed on the length of cable including the splice, with the existing cables being tested to the nearest disconnection point.

3.4 REPORTS

A. The testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to the Engineer.

END OF SECTION

SECTION 26 0519

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. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. General Cable Corporation.
2. Senator Wire & Cable Company.
3. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

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. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded for all.

B. Branch Circuits: Copper. Stranded for all.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN, THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips,that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

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 and UL 486B.

B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm).

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.

C. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 0526

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. This Section includes methods and materials for grounding systems and equipment**.**

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Ground bonding common with lightning protection system.

2. Refer to Specification Section 270526 for Grounding requirements for Communication Equipment.

1.3 SUBMITTALS

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

B. As-Built Data: 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.

1.4 QUALITY ASSURANCE

A. 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.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

2.3 GROUNDING ELECTRODES

Ground Rods: Copper-clad steel 3/4 inch diameter by10 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors for all ground wires, unless otherwise indicated.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. 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.

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.

END OF SECTION

SECTION 26 0529

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. Section 260548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. 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.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Welding certificates.

C. Seismic Qualification Certificates: For hangers and supports, 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.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. Thomas & Betts Corporation.
e. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. 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.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
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.

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 and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT**,** IMC, 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 (90 kg).

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 New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Existing Concrete: Expansion anchor fasteners.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
5. To Light Steel: Sheet metal screws.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

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

END OF SECTION

SECTION 26 0533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. LFMC: Liquidtight flexible metal conduit.

D. LFNC: Liquidtight flexible nonmetallic conduit.

E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

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.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. Alflex Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. O-Z Gedney; a unit of General Signal.
4. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed. Coordinate first subparagraph below with Drawings.

1. Fittings for EMT: Compression type.

2.2 BOXES, ENCLOSURES, AND CABINETS

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

1. Erickson Electrical Equipment Company.
2. Hoffman.
3. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
4. O-Z/Gedney; a unit of General Signal.
5. RACO; a Hubbell Company.
6. Robroy Industries, Inc.; Enclosure Division.
7. Spring City Electrical Manufacturing Company.
8. Thomas & Betts Corporation.

B. Sheet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

F. Hinged-Cover Enclosures: 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.

G. 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.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: RGS, Use EMT in Office Areas.
2. Exposed, Not Subject to Severe Physical Damage: RGS, Use EMT in Office Areas.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit.
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: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from ENT to rigid steel conduit, or EMT before rising above the floor.

I. 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.

J. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed lighting fixtures, 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.

K. 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.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.

C. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 0548

VIBRATION AND SEISMIC CONTROLS 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. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.

B. Related Sections include the following:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC:, design category B.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

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

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

C. Pads : Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

D. Spring Isolators : Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators : Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. Hilti Inc.
4. Loos & Co.; Seismic Earthquake Division.
5. Mason Industries.
6. TOLCO Incorporated; a brand of NIBCO INC.
7. Unistrut; Tyco International, Ltd.

C. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

G. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

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

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

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

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment:

1. Equipment Location: <**Insert room number**>.
2. Pads:

a. Material: [**Neoprene**] [**Rubber**] [**Hermetically sealed compressed fiberglass**].
b. Thickness: <**Insert inches (mm)**>.
c. Durometer: <**Insert number**>.
d. Number of Pads: <**Insert number**> thick.

3. Isolator Type: <**Insert generic name or designation used in Part 2**>.
4. Component Importance Factor: [**1.0**] [**1.5**].
5. Component Response Modification Factor: [**1.5**] [**2.5**] [**3.5**] [**5.0**].
6. Component Amplification Factor: [**1.0**] [**2.5**].

END OF SECTION

SECTION 26 0553

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. This Section includes the following:
   1. Identification for conductors.
   2. Equipment identification labels.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, 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 CONDUCTOR MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a black background. Minimum letter height shall be 3/8 inch (10 mm).

PART 3 - EXECUTION

3.1 APPLICATION

A. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

B. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and 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.

2. Equipment to Be Labeled:

   a. Panelboards, electrical cabinets, and enclosures.
   b. Transformers.
   c. Disconnect switches.
   d. Push-button stations.

3.2 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. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Colors for 208/120-V Circuits:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Neutral: White
   e. Ground: Green

2. Colors for 480/277-V Circuits:

   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: White
   e. Ground: Green

3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION

SECTION 26 2200

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 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

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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 IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 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 in Division 03.

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. ACME Electric Corporation; Power Distribution Products Division.
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
5. General Electric Company.
6. Siemens Energy & Automation, Inc.
7. Sola/Hevi-Duty.
8. 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 Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

H. Wall Brackets: Manufacturer's standard brackets.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

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 Division 26 Section "Grounding and Bonding for Electrical Systems" 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 Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

3.3 CONNECTIONS

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

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

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2413

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. Disconnecting and overcurrent protective devices.

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 and the unit will be fully operational after the seismic event.

1.4 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 features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. 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.
8. 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.

D. Qualification Data: For qualified Installer.

E. 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.

F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "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.

1.5 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. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. 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.

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 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

1.6 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 connect factory-installed space heaters to temporary electrical service to prevent condensation

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 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.

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. 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. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

D. Nominal System Voltage: Refer to the Plans.

E. Main-Bus Continuous: Refer to the Plans.

F. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

G. Indoor Enclosures: Steel, NEMA 250, Type 1.

H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

I. Barriers: Between adjacent switchboard sections.

J. Fire pump section shall in a separate section with barriers on both sides per NEC 695.

K. Insulation and isolation for main bus of main section and vertical buses of feeder sections.

L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

M. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, tin-plated aluminum or copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. 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.
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.

N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

O. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 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.
2. Breakers 225A frame size and larger shall have Electronic trip with LSI for following:

a. Continuous Current Setting.

b. Long Time Delay.
c. Instantaneous Overcurrent.
d. Short Time Pick-up
e. Short Time Delay

3. 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.

2.3 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.5 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. 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 NEMA PB 2.1.

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 NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. 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.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. 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 Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

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

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

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.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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

E. 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.

3.5 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 indicated.

3.6 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 2416

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. Lighting and appliance branch-circuit panelboards.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective 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. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. 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.

C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
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. Qualification Data: For qualified testing agency.

E. 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.

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories 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 PB 1.

D. Comply with NFPA 70.

1.5 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.

1.6 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. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces.

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.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Finishes:

a. Panels and Trim: galvanized 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: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

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.

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.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 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 as shown on the plans.

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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 NEMA PB 1.1.

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 NEMA PB 1.1.

B. Mount top of trim 90 inches above finished floor unless otherwise indicated.

C. 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.

D. Install overcurrent protective devices and controllers not already factory installed.

E. Install filler plates in unused spaces.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. 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.

END OF SECTION

SECTION 26 2726

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. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches
3. Weatherproof covers.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

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

B. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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

C. Comply with NFPA 70.

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; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Ground strap is to be brass.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. Must have the capability to self test every two minutes.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; GF20.
b. Pass & Seymour; 2084.
c. Hubbell; GFR5352ST

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch- (1-mm-) thick..
3. Material for Unfinished Spaces: Stainless steel smooth finish type 302.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant**,** die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
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 just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
2. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
3. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
4. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
5. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
6. Tighten unused terminal screws on the device.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

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.

END OF SECTION

SECTION 26 2816

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. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers.
4. Enclosures.

1.3 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

1.4 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, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Field quality-control test reports including the following:

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.

C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

D. 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.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Available Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two 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; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Available Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, 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.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations or as noted on the plans: NEMA 250, Type 3R.

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.

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

3.2 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

B. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

A. Set field-adjustable switches.

3.6 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

SECTION 26 3213

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 standby engine-generator set with the following features:

1. Diesel engine. (800 KW)
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Sound Attenuated Weatherproof Enclosure.
5. Battery and battery charger.
6. One (1) Remote annunciators.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 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 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.

C. Qualification Data: For manufacturer.

D. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

H. Manufacturer Seismic Qualification Certification: Submit certification that [**day tank,**]engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. 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 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

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

E. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 99.

I. Comply with NFPA 110.

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.

1.6 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. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

1.7 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 shown on the plans.

1.8 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 to include service call charges.

1.9 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.

1.10 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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

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: Diesel.

B. Rated Engine Speed: 1800 rpm.

C. 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.

D. Engine Fuel System:

1. Diesel.

E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

F. Governor: Adjustable isochronous, with speed sensing.

G. 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 (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
   b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. 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 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. 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 three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. 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 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates

generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, 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.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

E. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

F. 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.

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

L. Voltage: Refer to the plans.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). 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. Provide Generator Housing as specified:

1. Weatherproof.
2. Muffler.
3. Sound Attenuating Aluminum Level 2 Enclosure.
4. Twelve gauge steel posts.
5. Removable panels and doors.
6. Corrosion resistant.
7. Chambered roof.
8. Lockable doors.
9. UL complaint.

2.8 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.9 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. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. 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 (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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 Division 23 Section "Hydronic Piping."

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 Division 23 Section "Hydronic Piping."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect engine exhaust pipe to engine with flexible connector.

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

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

3.4 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

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. Report results in writing.

B. Perform tests and inspections and prepare test reports.

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

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 (120 kPa). 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. Exhaust Emissions Test: Comply with applicable government test criteria.
8. 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.
9. 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.
10. 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 reinspect 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Provide Four (4) hours of training.

END OF SECTION

SECTION 26 3600

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 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. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

F. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

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

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify the Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the Owners written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Transfer Switches:
   a. Caterpillar; Engine Div.
   b. Generac Power Systems, Inc.
   c. Kohler Power Systems; Generator Division.
   d. Onan/Cummins Power Generation; Industrial Business Group.
   e. Russelectric, 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. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

I. Battery Charger: For generator starting batteries.

1. Float type rated 2 10 A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 2 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. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Automatic Open-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic break-before-make operation.

2. Failure of power source serving load initiates automatic break-before-make transfer.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
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. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

B. Identify components according to Division 26 Section "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

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

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

3.3 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

C. Testing Agency's Tests and Inspections:

1. After installing equipment and after 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. 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.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

D. Coordinate tests with tests of generator and run them concurrently.

E. 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.

F. Remove and replace malfunctioning units and retest as specified above.

G. 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 Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 26 4113

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, structure elements and building site components**.**

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 and LPI as a Master Installer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.
2. LPI System Certificate.
3. UL Master Label Recertification.

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, aluminum unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Heary Bros. Lightning Protection Co. Inc.
   b. Independent Protection Co.
   c. Preferred Lightning Protection.

C. Main and Bonding Conductors: Aluminum.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad [3/4 inch (19 mm) in diameter by 10 feet (3 mm) long.

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.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

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 (18 m) in length to lightning protection components.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

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.

C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION

SECTION 26 5100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LED: Light emitting diode

F. LER: Luminaire efficacy rating.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

H. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.

5. Life, output, and energy-efficiency data for lamps.
6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Luminaire installation instructions.

C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

D. Qualification Data: For agencies providing photometric data for lighting fixtures.

E. Field quality-control test reports.

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

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Provide support structures as required for various fixture installation locations such as under ductwork or other work that prevents fixture mounting to building structure.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

1.8 WARRANTY

A. Special Warranty for LED luminaires: Manufacturer's standard form in which the luminaire manufacturer agrees to repair or replace any failed components, material, or workmanship within specified warranty period.
   1. Warranty period for LED luminaires: Five (5) years minimum from the date of substantial completion.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in material or workmanship within specified warranty period.
   1. Warranty period for electronic ballasts: Minimum (1) one year from the date of substantial completion.
   2. Manufacturer shall supply new ballast for the ones that have failed within the warranty period. The replacement ballast shall be the same or an improvement to the original design.

C. Special Warranty for T8, T5, & T5HO Fluorescent Lamps: Manufacturer's standard form in which lamp manufacturer agrees to repair or replace lamps that that fail in material or workmanship within specified warranty period.
   1. Warranty period for linear fluorescent lamps: One (1) years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Luminaire Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 42 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.85 or higher.
7. Power Factor: 0.95 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

2.4 LED SYSTEMS

A. The LED array module or LED board and all it’s components shall be subject to mechanical stress.

B. Assembly shall not be put together in such a way as to damage or destroy conducting paths of the LED circuit board.

C. Installation of LED modules and all its components that are required for operation, including power supplies shall comply with all applicable electrical safety standards.

D. Electrical polarity shall be clearly identified or the connectors shall be designed in a way that polarity can't be reversed when the modules are electrically plugged in.

E. LED modules shall be installed in specifically designed housing or be tested in a housing that has the proper thermal heat sinking properties to support LED array installation.

F. LED circuit board shall be protected by a coating against moisture and dust. The coating shall be factory applied,

G. The LED array module shall be operated with an electronically stabilized power supply offering protection from short circuits, overload, and overheating.

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay

disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.7 FLUORESCENT LAMPS

A. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours, unless otherwise indicated.

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

C. Adjust aimable lighting fixtures to provide required light intensities.

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

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION

SECTION 26 5600

EXTERIOR LIGHTING

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. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

B. Related Sections:

1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LED: Light emitting diode.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. Pole: Luminaire support structure, including tower used for large area illumination.

H. Standard: Same definition as "Pole" above.

1.4 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
6. Retain one of first two subparagraphs below. Retain "Testing Agency Certified Data" Subparagraph if photometric data for one or more luminaires are based on independent laboratory tests; coordinate with the Exterior Lighting Device Schedule on Drawings to indicate which units are required to meet this requirement. Retain "Manufacturer Certified Data" Subparagraph if photometric data based on testing by accredited manufacturers' laboratories are considered adequate for all exterior luminaires in this Project. See Evaluations.

7. Photoelectric relays.
8. Ballasts, including energy-efficiency data.
9. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
10. Materials, dimensions, and finishes of poles.
11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
12. Anchor bolts for poles.
13. Manufactured pole foundations.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

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 IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.
   1. .

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   1. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.
b. Color: Match Architect's sample of [manufacturer's standard] [custom] color.
c. Color: As selected by Architect from manufacturer's full range.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F and higher.

2.5 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.6 HID LAMPS

A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

2.7 LED FIXTURES

A. Requirements for LED Fixtures

1. Minimal Characteristics

   a. CRI: 80
   b. Lamp Life: 100,000 hrs
   c. Color Temperature: 4000 K.

2. LED fixtures, lamps, and drivers shall meet the following standards.

   a. IES LM-79-2008, Approved Method for the Electrical and Photometric Testing of Solid-State Lighting Devices
   b. IES LM-80-2008, Approved Method for Measuring Lumen Depreciation of LED Light Sources
   c. IES TM-21-2011, Projecting Long Term Lumen Maintenance of LED Light Sources
   d. NEMA SSL 1-2010, Electronic Drivers for LED Devices, Arrays, or Systems
   e. NEMA SSL 4-2012, Retrofit Lamps: Minimum Performance Requirements
   f. NEMA SSL 6-2010, Solid State Lighting for Incandescent Replacement—Dimming
   g. ANSI/NEMA/ANSLG C78.377. Specifications for the Chromaticity of Solid State Lighting Products

3. Outdoor applications: Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

4. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires

2.8 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

2.9 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

F. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind

welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top at grade.

3.5 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
d. IESNA LM-64, "Photometric Measurements of Parking Areas."
e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 26 5610

LARGE AREA LIGHTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.

B. The purpose of these specifications is to define the performance and design standards for GLTC. The manufacturer shall supply lighting equipment to meet or exceed the standards set forth by the criteria set forth in these specifications.

C. Lighting will be for the following area:

1. Equipment Yard

D. The primary goals of this Large Area Lighting project are:

1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of all persons within the designated area. Therefore the lighting system shall be designed such that the light levels are guaranteed for a period of 10 years.
2. Environmental Light Control: The designated area is located in the Equipment Yard. It is the primary goal of this project to minimize spill light and glare.
3. Life Cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated during the 10-year life cycle.

1.3 LIGHTING PERFORMANCE

A. Performance Requirements: The designated area shall be lit to an average constant light level and uniformity as specified in the chart below. Light levels shall be held constant for 4380 hours per year for 10 years. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Measured average illumination level shall be +/- 10% of predicted mean in accordance with IESNA RP-6-01, and measured at the first 100 hours of operation.

Area of Lighting	Average Constant Light Levels	Grid Points	Grid Spacing

Equipment Yard	4 footcandles	345	30’ x 30’

B. Mounting Heights: To ensure proper aiming angles for reduced glare and off site light spillage, the pole mounting heights for the designated area shall be 70’ poles.

1.4 LIFE CYCLE COSTS

A. Energy Consumption: The average kWh consumption for the designated area shall be 21.28kw or less.

B. Complete Lamp Replacement: Manufacturer shall include all group lamp replacements required to provide 10 years of operation based upon 4,830 usage hours per year.

C. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for 10 years from the date of equipment shipment. Individual lamp outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

D. 10-Year Life Cycle Cost: Manufacturer shall submit 10-year life cycle cost calculations as follows. Equipment price and total life cycle cost shall be entered separately on bid form.

a.	Luminaire energy consumption # luminaires x __kW demand per luminaire x $0.12 kWh rate x 4380 annual usage hours x 10 years		
b.	Demand charges, if applicable	+	
c.	Cost for spot relamping and maintenance over 10 years Assume 3 repairs at $ 500 each if not included with the bid	+	
d.	Cost to relamp all luminaires during 10 years 4380 annual usage hours x 10 years / lamp replacement hours x $125 lamp & labor x # fixtures if not included with the bid	+	
	TOTAL 10-Year Life Cycle Operating Cost	=	

1.5 WARRANTY AND GUARANTEE

A. 10-Year Warranty: Each manufacturer will supply their own specific written warranty covering lamp replacements, parts, labor and performance as specified above for 10 years. Manufacturer shall maintain specifically funded financial reserves to assure fulfillment of the warranty for the full term. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations.

Manufacturer shall guarantee constant light levels specified above for 12,000 hours.

1.6 DELIVERY TIMING

A. Equipment On-Site: The equipment must be on-site 4-6weeks from receipt of approved submittals and receipt of complete order information.

1.7 PRE-BID SUBMITTAL REQUIREMENTS

A. Approved Product: Musco's Light-Structure Green™ System is the basis of design. All substitutions must provide a complete submittal package for approval as outlined in Submittal Information at the end of this section at least 10 days prior to bid. Special manufacturing to meet the standards of this specification may be required. An addendum will be issued prior to bid listing any other approved lighting manufacturers and designs.

B. Design Approval: The owner / engineer will review pre-bid shop drawings from the manufacturer's to ensure compliance to the specification. If the design meets the design requirements of the specifications, an addendum will be issued indicating approval for the specific design submitted.

1.8 ALTERNATE SUBMITTAL REQUIREMENTS

A. Compliance to Specifications: Acceptance of a bid alternate does not negate the contractor and lighting manufacturer's responsibility to comply fully with the requirements of these specifications. Any exceptions to the specifications must be clearly stated in the prior approval submittal documents.

B. Light Level Requirements: Manufacturer shall provide computer models guaranteeing light levels on the field 12,000 hours. If a constant light level cannot be provided, a maximum Recoverable Light Loss Factor of 0.70 shall be applied to the initial light level design to achieve the following Initial and maintained light levels. For alternate systems, scans for both initial and maintained light levels shall be submitted.

C. Revised Electrical Distribution: Manufacturer shall provide revised electrical distribution plans to include changes to service entrance, panel, and wiring size.

Area of Lighting	Average Initial Light Levels	Average Target/Maintained Light Levels	Grid Points	Grid Spacing
Parking Area	5.7 footcandles	4 footcandles	345	30' x 30'

1.9 ELECTRICAL SYSTEMS REQUIREMENTS

A. Contractor Responsibility: The installing contractor shall be responsible for providing the equipment and installation of a complete and operational system commencing from the load side of the distribution and terminating at the safety disconnect within the electrical enclosure, 10' above grade, on each lighting pole. The contractor shall coordinate the locations, as well as identifying the voltage and phase of the service, before any equipment is installed.

B. Electrical requirements for the lighting system:

C. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.

D. System Design

1. The electrical system equipment shall consist of:

A. The panel board with appropriate individual circuit over-current protection. All feeder breakers shall be bolt on type.

B. Conductors and conduit for the feeder circuit from the panel board (or from the contactor panel if applicable) to the safety disconnect mounted in the electrical enclosure on each lighting pole 10” above grade.

C. Grounding conductors and grounding methods for the following:

1. The main service entrance panel board. (Per NEC or local codes)
2. The lighting contactor enclosure. (Per NEC or local codes)
3. Each electrical component enclosure mounted on the lighting poles. (Equipment Grounding System) (Per NEC or local codes)
4. Lightning Protection for individual poles as follows (per NFPA 780):
   a. A 5/8” x 10’ copper grounding rod buried vertically in undisturbed earth. The bottom tip of the grounding rod should reach a minimum of 10’ below grade.
   b. A copper grounding conductor shall be connected to the top of the copper ground rod and extend and connect to the grounding lug located inside the handhold of the pole approximately 10’ above grade. The size of the conductor shall be #2 if the pole is less than 75’ in height and #2/0 if the pole is 75’ in height or greater.

2. Underground wiring shall be all copper wire and shall be installed in PVC Schedule 40 conduit and shall be buried to a depth meeting the NEC and local electrical codes. Acceptable copper wire types need to comply with any local requirements, but will be labeled either THHN or THWN. If above ground conduit must be used it shall be rigid galvanized steel. Conduit elbows located at the electrical panel should be rigid conduit, as opposed to PVC.

A. Trenching or Directional Boring

1. The installing contractor shall be responsible for location all underground utilities including, but not limited to, natural gas, electric, water, sewer, cable TV and telephone.
2. Trenching depth and width shall be adequate to install appropriately sized conduit and to meet local and National Electrical Codes.
3. Trenches shall be back-filled with excavated soil and compacted to approximately the same density of the surrounding soil to minimize settlement.
4. No trench line or feeder circuit shall cross the playing area.
   1. Design Standards
      1. All Circuits shall be designed so as not to exceed a 3% voltage drop at the safety disconnect in the electrical enclosure near the base of each pole.

2. All work shall meet local and National Electrical Codes. It shall be the installing contractors' responsibility to correct any work deemed unacceptable by local electrical inspectors.
3. All electrical components shall be UL Listed for the appropriate application.
4. Each pole shall be on a dedicated circuit. If common poles are to be used, or a pole is to have fixtures on a separate circuit, another dedicated circuit shall be ran to that pole. Consult lighting equipment specifications and lighting manufacturer for special circuitry information.

3. Submittal Information

A. The successful contractor shall provide an electrical plan/schematic, detailing all of the equipment described above, to the owner prior to commencing work. This electrical plan/schematic shall bear the stamp of an Electrical Engineer with P.E. status within the State.

PART 2 – PRODUCT

2.1 LIGHTING SYSTEM CONSTRUCTION

A. System Description: Lighting system shall consist of the following:

1. Galvanized steel poles and crossarm assembly
2. Pre-stressed concrete base embedded in concrete backfill allowed to cure for 12-24 hours before pole stress is applied. Alternate may be an anchor bolt foundation designed such that the steel pole and any exposed steel portion of the foundation be located a minimum of 18 inches above final grade. The concrete shall be allowed to cure for a minimum of 28 days before the pole stress is applied.
3. All luminaries shall be constructed with a die-cast aluminum housing or external hail shroud to protect the luminaire reflector system.
4. Manufacturer will remote all ballast and supporting electrical equipment in aluminum enclosures mounted approximately 10' above grade. The enclosures shall include ballast, capacitor and fusing for each luminaire. Safety disconnect per circuit for each pole structure will be located in the enclosure.
5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
7. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaries, wire harnesses, ballast and other enclosures shall be factory assembled, aimed, wired and tested.

8. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated for protection against corrosion and stress corrosion cracking. All wiring shall be enclosed within the crossarms, pole, or electrical components enclosure.

2.2 STRUCTURAL PARAMETERS

A. Support Structure Wind Load Strength: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be determined based on the 2009 edition of the IBC Building Code, wind speed of 100mph. Luminaire, visor, and crossarm shall withstand 150 mph winds and maintain luminaire-aiming alignment. Foundation design will be based on IBC.

B. Structural Design: The stress analysis and safety factor of the poles shall conform to AASHTO 2001 (LTS-4) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

C. Soil Conditions: The design criteria for these specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not provided by the owner, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2001 IBC, Table 1804.2-I-A OR 1997 UBC, Table 18-I-A.

   It shall be the contractor's responsibility to notify the owner if soil conditions exists other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the owner's approval / payment for additional costs associated with:

   a) Providing engineered foundation embedment design by a registered engineer in the State of Virgina.
   b) Additional materials required to achieve alternate foundation.
   c) Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

PART 3 – EXECUTION

3.1 CONTRACTOR'S DUTIES

All work performed under this contract shall be performed in accordance with all provisions of these specifications and drawings. Any deviations from the specifications or plans must be approved in writing by the owner or his representative.

A. Initial site inspection: The contractor shall be presumed to have made a reasonable inspection of the premises prior to the time of bidding and shall be held responsible for all information available through such inspection. The contractor shall immediately upon discovery, bring to the attention of the owner any conflicts that may occur among the various provisions of the specifications and plans. The owner shall resolve such conflicts and shall be responsible for any costs reasonably incurred by the contractor due to such conflict. Failure of the contractor to bring conflicts or exceptions to the attention of the owner shall allow the owner to require any change deemed necessary before acceptance by the owner.

B. The successful contractor shall, upon completion of the project, protect the owner against defective materials or faulty workmanship for a period of two (2) years. The contractor, at the owner's request, shall furnish a maintenance bond for the above outlined maintenance term. This bond shall be in an amount not to exceed one hundred percent (100%) of the contract price.

C. Codes, Permits and Licenses: All work shall comply with the applicable rules of the National Electrical Code, the National Electrical Safety Code, the National Fire Codes, (published by the National Fire Protection Association), state and local codes and ordinances, and the terms and conditions of the services of the electrical utility, as well as any other authorities that may have lawful jurisdiction pertaining to the work specified. None of the terms or pro-visions of this specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. The contractor shall procure all necessary permits or licenses to carry out his work, and shall pay the lawful fee therefore, as well as for any inspection fee or the cost of a certificate of approval.

   In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. The codes shall govern in the case of direct conflict between the codes and the plans and the specifications.

3.2 MATERIALS

A. Approved Materials: All materials supplied by the contractor under the provisions of these specifications and plans shall be new materials of the kind and character called for by the specifications. Defective equipment or material damaged in the course of installation or tests shall be replaced or repaired in a manner satisfactory to the owner. All materials and equipment to be furnished under these specifications shall be the standard product of a manufacturer regularly engaged in the production of such material and shall be the manufacturer's current standard design.

B. Alternate Materials: The materials specified have been determined to have characteristics appropriate for the purposes of this project. Alternate materials will only be considered as a substitute bid on a separate substitution sheet. No bid will be approved which proposes to use a non-approved substitute. Substitutions will not be considered in determining the lowest responsive bid. The owner reserves the right to reject any or all bids.

3.3 SITE ACCESS

A. Contractor Access: For the performance of the contract, the contractor will be permitted to occupy such portions of the site as shown on the plans, or as permitted by the owner or his representative. A reasonable amount of tools, materials or equipment for construction purposes may be stored in such place, but not more than is necessary to avoid delays in construction. Excavated and waste materials shall be piled or stocked in such a way as to not interfere with spaces that may be designated to be left free and unobstructed, not to inconvenience other contractors or the owners.

   Upon completion of the work and before acceptance and final payment is made, the contractor shall clean and remove from the site of the work, surplus and discarded materials, temporary structures and debris of every kind. The contractor shall leave the site of work in a neat and orderly condition equal to that which originally existed. Surplus and waste materials removed from the site of the work shall be disposed of at locations satisfactory to the owner.

B. Owner's Access: The owner's representative shall at all times have access to the work site. The contractor shall keep the owner advised of the progress of the project and shall provide opportunity for the owner or his representative to inspect each phase of the project. The contractor shall provide proper and safe facilities for such access and for inspection.

3.4 REPLACEMENT OF DAMAGED PROPERTY

A. The contractor shall replace all property damaged by him including fences, trees, plants, grass, walks, drives, building surfaces, etc.

3.5 INSTALLATION

A. Manufacturer's Instructions: Written instructions for the installation of the sports lighting equipment shall be provided by the manufacturer. The contractor shall review the instructions prior to beginning installation and review any areas of concern with the manufacturer.

B. Manufacturer Representative: A qualified representative from the sports lighting manufacturer shall be available to provide installation guidance if required by the contractor.

C. Rigging: Use the appropriated rated web fabric slings to lift components into position. Chains or cables shall not be allowed due to potential failure and damage to components.

D. Clean-up: Upon completion of the work and before acceptance and final payment is made, the contractor shall clean and remove from the site of the work, surplus and discarded materials, temporary structures and debris of every kind. The contractor shall leave the site of work in a neat and orderly condition equal to that which originally existed. Surplus and waste materials removed from the site of the work shall be disposed of at locations satisfactory to the owner.

3.6 FIELD QUALITY CONTROL

A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-01, Appendix B.

B. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles, uniformity ratios, and maximum kilowatt consumptions are not in conformance with the requirements of the performance specifications and submitted information, the Musco shall be liable to any or all of the following:

1. Musco shall at his expense provide and install any necessary additional fixtures to meet the minimum lighting standards. The Musco shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.

2. Musco shall minimize the Owner's additional long-term fixture maintenance and energy consumption costs created by the additional fixtures by reimbursing the Owner the amount of $1,000.00 (one thousand dollars) for each additional fixture required.

3. Musco shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications.

SUBMITTAL INFORMATION- Alternate Manufacturers Only

Design Submittal Data Checklist and Certification

All items listed below are mandatory, shall comply with the specification and be submitted according to pre-bid submittal requirements

Included	Tab	Item	Description
	A	Letter/ Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	Parking Area Lighting Design	Lighting design drawing(s) showing: a. Field Name, date, file number, prepared by, and other pertinent data b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y). Illuminance levels at grid spacing specified c. Pole height, number of fixtures per pole, as well as luminaire information including wattage, lumens and optics d. Height of meter above field surface e. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance and uniformity gradient; number of luminaries, total kilowatts, average tilt factor; light loss factor. f. Alternate manufacturers shall provide both initial and maintained light scans using a maximum 0.70 Light Loss Factor to calculate maintained values.
	C	Life Cycle Cost calculation	Document life cycle cost calculations as defined in the specification. Identify energy costs for operating the luminaires, maintenance cost for the system including spot lamp replacement, and group relamping costs. All costs should be based on 10 Years.
	D	Luminaire Aiming Summary	Document showing each luminaire's aiming angle and the poles on which the luminaries are mounted. Each aiming point shall identify the type of luminaire.
	E	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of Virgina.
	F	Electrical distribution plans	If bidding an alternate system, manufacturer must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of Virgina.
	G	Performanc e Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed per specification for 10 years.
	H	Warranty	Provide written warranty information including all terms and conditions.
	I	Project References	Manufacturer to provide a list of project references of similar products completed within the past three years.
	J	Product Information	Complete set of product brochures for all components, including a complete parts list and UL Listings.

	K	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications.
	L	Compliance	Manufacturer shall sign off that all requirements of the specifications have been met at that the manufacturer will be responsible for any future costs incurred to bring their

			equipment into compliance for all items not meeting specifications and not listed in item N – Non-Compliance

Manufacturer: _____ *Signature:* _____

Contact Name: _____ *Date:* _____/_____/_____

END OF SECTION

DIVISION 27
COMMUNICATIONS

SECTION 27 0526

COMMUNICATIONS GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 and 26 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. This section describes hardware, and installation methods that the Contractor shall use to insure the installation of a competent grounding system that will avoid/minimize ground-loops, and Electromagnetic Interference (EMI) problems in the operation of the communications systems installed under this Contract. In addition to the methods detailed in this Section, the Contractor shall insure that his crews adhere to all generally accepted installation practices that are meant to minimize interference between communications systems.

B. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.

C. Equipment and Rack Grounding.

D. Cable Shield Grounding.

1.3 RELATED SECTIONS

A. Section – 260526 Grounding and Bonding

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings: Indicate electrical system wiring diagram.

PART 2 - PRODUCTS *Not Used*

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground Communication system and facilities, equipment and cables using a single-point grounding scheme. Each Communication Equipment Room will have a separate isolated ground bus bar designated as a communications ground.

B. Unless otherwise specified, ground the shields of all single shielded communications cables, the shields of multi-conductor cables that have individual shielded pairs, and the inner shield of all double shielded communications cables and communications cables with separate shield and armor only at a single point and only to the a communications ground. These shields shall be electrically continuous throughout the cable length by bonding across all splices and terminations in equipment enclosures and junction boxes.

C. Ground the outer shield of all double-shielded communications cables and the armor of all communications cables with separate shield and armor only at a single point in each cable section. Locate the single point ground at the end of the cable section nearest to the associated Communications Equipment Room. Ground outer shield or armor Cable sections originating at Communications Equipment Rooms to the "communications ground."

D. Electrically isolate equipment racks and equipment cabinets from the building structure, adjacent equipment racks and equipment cabinets. Minimum resistance between adjacent equipment racks and equipment cabinets, and between equipment racks and equipment cabinets and the building structure, shall be 10 meg-ohms. Individually wire each equipment rack and equipment cabinet to the communications ground, via the copper ground bus bar on the equipment rack and equipment cabinet, by a No. 6 AWG, stranded, insulated wire, Type XHHW.

E. Wire each copper ground bus bar in the multi-section cable terminal housings of the Main Distribution Frame (MDF)/ MDF/Protector Cabinet and the systems distribution frames to the communications ground by a No. 6 AWG, stranded, insulated wire, Type XHHW.

F. Electrically insulate all power conductors from equipment racks and equipment cabinets, with a separate power ground isolated from communications ground. Insulate Conduit containing power conductors running from ac distribution boxes to equipment racks, equipment cabinets, ac receptacle boxes on equipment racks and equipment cabinets from the equipment cabinet or equipment rack by means of short lengths of non-conducting conduit.

G. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bus bar (TGB).

H. The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.

I. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

J. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape.

K. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

END OF SECTION

SECTION 27 1500

COMPUTER/TELEPHONE NETWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Local Area Network (LAN) and telephone cabling system, terminations, labeling and associated cable performance testing.

B. Related Sections

1. Section 260500 – Common Work Results for Electrical.
2. Section 260533 – Raceways and Boxes for Electrical Systems.

1.2 SYSTEM DESCRIPTION

A. Design Requirements

1. Network: Provide labor, materials, equipment, services and operations required for installation of LAN and telephone compatible with Ethernet 10 Base T (10Mbs), Fast Ethernet 100 Base T (100Mbs), and Gigabit Ethernet, with Category 6 copper horizontal (station) wiring.

a. Network formed at distribution rack wiring closet, designated on Drawings, star wired to computer jacks in offices and elsewhere.

1) Cat. 6, UTP wiring terminates on RJ45 wall jack and on RJ45 patch panels at distribution rack. LAN and telephone shall be terminated on separate patch panels. LAN connections wired per EIA/TIA 568A.

b. Network cables routed from distribution rack throughout building in ceiling cavity or other locations as shown on Drawings, drop-in conduit to communications outlet in offices at locations indicated on Drawings.

1) Refer to notes on drawing to determine exact installation methods.
2) Note and record all cable lengths to nearest foot.
3) Replace any cable exceeding 97 meters (318 feet) long and route to reduce length to 97 meters or less. Complete all cable re-routing at no additional cost to Owner.
4) Identify to Architect prior to installation any cables that cannot be reduced to 97 meters or less in length.
5) Strictly adhere to most current BICSI Category 6 wiring installation standard.

c. Data Outlet: Enhanced Category 6 rated RJ45 type connectors with all 4 copper pairs terminated and tested in accordance with EIA (568A) wiring standard.

d. Permanently identify and label all cables and termination devices, at distribution rack and classroom data outlet in accordance with specified requirement with designations determined by Owner.
e. Remove and replace any cables failing to meet end-to-end testing; do not abandon cable in place.

B. Performance Requirements

1. Comply with applicable requirements in Local, State and Federal Codes and both TIA-EIA and BICSI standards.

1.3 SUBMITTALS

A. Comply with requirements of 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 specified requirements.

1. Distribution rack, patch panels and all required rack accessories.
2. Communication outlets.
3. Copper cables, patch cables and terminations.
4. Rack configurations and wiring diagrams.
5. Un-interruptible power systems.
6. Network cabling test equipment and routines.
7. Sample of each network cabling test report.

C. Quality Control Submittals

1. Test Reports: Submit complete test data and reports with exact labels used on cables, patch panels and face plates.
2. Certificates

a. Manufacturer Certification: Submit certification from manufacturer or products to be installed as part of this Project certifying that Installer is authorized by product manufacturer to install proposed products.

3. Installer Experience Listing: Submit a list of at least 5 completed projects as specified below in "Quality Assurance – Qualifications – Installer".

D. Contract Closeout Submittals: Comply with requirements of Division I, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual

1.4 QUALITY ASSURANCE

A. Qualifications

1. Installer

a. Qualified to cable, terminate and test data network cabling system specified in this Section, certified by manufacturer or products to be installed, and completed at

least 5 computer network installations of similar size, nature and complexity as specified for this project.

1.5 MAINTENANCE AND WARRANTY

A. Maintenance Service: Completely service all installed components for 1 year after final acceptance. Provide 4 quarterly inspections and service calls on system and make any adjustments and/or repairs required at no additional cost to Owner. Provide minimum 15 year warranty for all installed cable.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Distribution Rack

1. Floor mounted
2. Manufacturers: For convenience, details and specifications based on Cat. No. GL840E-2436 by Great Lakes. Other manufacturers offering acceptable products include ADH Custom Metal Fabricators, Inc, Hoffman, Chatsworth, AMP or Hubbell.
3. Cabinet: 84 inch high x 24 inch wide x 36 inch deep, suitable for 19 inch wide equipment, with black anodized finish.
4. Solid, locking door
5. Adjustable mounting rails (2 pair)
6. Ground: Provide #6 minimum ground wire from data racks to the ground bar.
7. Provide 4 racks, three in the server room and one in wiring closet room in the service building (racks keyed the same, but different from all other racks.
8. Category 6 Patch Panels
9. Fiber Patch Panels
10. Provide one APC SMART-UPS RT 1500VA 120V for each rack.

B. Patch Panels

1. Category 6 Patch Panels

   a. Manufacturers – For convenience, details and specifications based on:

      1) LAN568A Wiring Plan: Part No. 48845-C6 by LeGrand/P&S.

   b. Rack mounted unit, suitable for standard 19 inch equipment rack, providing interconnect between horizontal wiring and patch cable to wiring hub.
   c. Category 6, 48 port, 100 wiring connection with (48) RJ45 connectors.
   d. Exact quantity of patch panels at each rack location determined by total quantity of incoming cables being terminated, plus 20% spare capacity for future expansion.
   e. Provide separate patch panels for LAN and telephone.
   f. LAN patch cords shall connect from the LAN patch panels to the LAN equipment.

2. Fiber Optic Patch Panels

   a. Manufacturers – Specification is based on Panduit Opticom:

b. Rack mounted by LeGrand/P&S or equal by AMP, Panduit or Hubble.
c. Provide one 12 port Multimode and one 12 port Single-mode Panels in each rack .

C. Copper Twisted-Pair Data Cables

1. Category 6 Unshielded Twisted Pair (UTP) Horizontal Cable: Category 6, 4-PR, 24 AWG Solid annealed copper cable.

a. Characteristics and Requirements: Provide and submit test reports for each reel.

1) Meet E.I.A./T.I.A. 568-C.2 transmission requirements.
2) Exhibit at least 20 dB ACR (Attenuation to Cross-Talk Ratio) minimum using worst pair NEXT testing at 155 MHZ frequency at 90 meters.
3) Exhibit at least 10 dB ACR (Attenuation to Cross-Talk Ratio) minimum using power sum NEXT testing at 100 MHZ frequency at 100 meters.
4) Plenum rated CMP in accordance with NEC section 800 and passed UL 910 flame test.
5) Plenum, Cat6, 4 pair UTP cable exhibiting minimum 18 dB headroom at 200 Mhz.
6) Minimum 4 pairs of cables insulated with FEP Teflon.
7) Meet ISO 11801 Standards and ISO 9000 certified.
8) Exhibit no more than 18 ns for skew delay.
9) Pass power sum testing and be independently tested.
10) Highest frequency tested to 350 MHZ minimum.
11) Cable jacket printed with minimum of following information:

a) Manufacturer
b) Part number
c) Cable type
d) Listing file number
e) Number of pairs
f) UL listing type (i.e. CMP)
g) Sequential footage markings.

12) Provide blue color outer jacket for data station wiring and yellow for telephone (verify color with Architect prior to installation).

2. Category 6 UTP Patch Cables: Factory assembled, Enhanced Category 6, 4-PR, 24 AWG solid, unshielded twisted pair cable, with male RJ45 connectors at each end. Exact lengths as determined in field and based on actual rack layouts. Provide exact quantity as required to patch all rack terminated ports to intelligent hub ports, plus 10% spare.

a. Cable length: 2.5 meters to 3 meters, unless otherwise specified.
b. Colors shall match the station cable colors.

D. Outlets: Modular construction with multiple inserts available to support different mediums, connectors and blank inserts for each outlet with connectors to meet RJ45 Category 6 specifications and wiring per EIA 568A. Provide 4 port face plates with 3 jacks (2-data, 1-telephone) and 1 blank inserts. Provide mounting hardware and configuration that provides proper bending radius for all installed cabling. Provide blue color modular jacks for data and yellow for telephone (verify color with Architect prior to installation.)

1. Face Plates: Mountable in recessed boxes.

   a. Manufacturers

      1) For convenience, modular jack details and specifications based on "P&S/ LeGrand".
      2) Other manufacturers offering acceptable products include Panduit, Ortronics, Hubbell and Wiremold.

   b. Single Supplier: Provide all connectors, face plates and all associated accessories supplied by same manufacturer, completely compatible with Section 260533 – Raceways and Boxes.

   c. Identification: Provide permanent Identification Labels for outlets, faceplates, patch panels, and other locations where specified. For convenience, details and specifications based on Brady TLS2200 PC Link Labels for voice/data identification.

E. Optical Fiber Cables: Used as backbone cable connecting all identified rooms on drawings, as trunk cable connecting buildings for plant wide data distribution system.

1. Fiber Optic Strands

   a. Multi-Mode Fiber Optic Strands: Ultra rated to 1Gbps, plenum rated fiber optic cable with 50/125um core/cladding diameters, 900mm buffer.

      1) Standards:

         a) UL listed for plenum use; meeting NEC, Article 770 – Optical Fiber Cables and Raceways and passed UL 910 flame test.
         b) Tight buffered fibers color coded in accordance with EIA/TIA-598 "Color Coding of Fiber Optic Cables".

      2) Fibers: Meet EIA/TIA 455-45A, Microscopic Method for Measuring Fiber Geometry of Optical Waveguides.

         a) Core Diameter: 50 +or- 3.0 um.
         b) Cladding Diameter: 125 +or- 2.0 um.
         c) Core to Cladding Offset: <- 1.5 um.
         d) All optical fibers proof tested at minimum of 100 kpsi and stress of 0.70 GN/m2 by manufacturer.
         e) Fiber Coating: Layer of acrylate protective coating in physical contact with cladding surface and removable with commercially available stripping tool in single pass and cleaned with 98% isopropyl alcohol.

      3) Typical Attenuation for optical fibers:

         a) 2.9 dB/Km 850 nm wavelength. (3.5 dB/Km max)
         b) 0.9 dB/Km at 1300 nm wavelength. (1.0 dB/Km max)

      4) Minimum LED transceiver Bandwidth Requirements:

         a) 200 MHZ at 1 Km at 850 nm wavelength.
         b) 500 MHZ at 1 Km at 1300 nm wavelength.
         c) Gigabit Ethernet performance guaranteed distance 400/1000 Meters.

      5) Cable Operating Temperature Range:

         a) Inside Cables: -20 degree C to +70 degree C.
         b) Outside Cables: -40 degree C to +70 degree C.

6) Cable Storage Temperature Range: -40 degree C to +70 degree C.
7) Maximum Tensile Load: 270 lbs. short term.

b. Single-Mode Fiber Optic Strands: H rated, plenum rated fiber optic cable with 8.3/125um core/cladding diameters, 900mm buffer.

1) Standards

a) UL listed for plenum use; meeting NEC, Article 770 – Optical Fiber Cables and Raceways and passed UL 910 flame test.
b) Tight buffered fibers color coded in accordance with EIA/TIA-598 "Color Coding of Fiber Optic Cables".

2) Fibers: Meet EIA/TIA 455-45A, Microscopic Method for Measuring Fiber Geometry of Optical Waveguides.

a) Core Diameter: 8.3 nominal.
b) Cladding Diameter: 125 +or- 2.0 um.
c) Core to Cladding offset <- 1.5 um.
d) All optical fibers proof-tested a minimum of 100 kpsi and stress of 0.70 GN/m2 by manufacturer.
e) Fiber Coating: Layer of acrylate protective coating in physical contact with cladding surface and removable with commercially available stripping tool in single pass and cleaned with 98% isopropyl alcohol.

3) Maximum Attenuation for Optical Fibers: 0.35 dB/Km 1310 nm wavelength.
4) Maximum Dispersion: <3.2 ps/nm/km at 1285-1330 nm wavelength.
5) Gigabit Ethernet Performance: Guaranteed distance 5000 Meters.
6) Cable Operating Temperature Range:

a) Inside Cables: -20 degree C to +70 degree C.
b) Outside Cables: -40 degree C to +70 degree C.

7) Cable Storage Temperature Range: -40 degree C to +70 degree C.
8) Maximum Tensile Load: 270 lbs. short term.
9) All terminations on single-mode optical fibers factory-made using machine-polished process and exhibiting maximum value of minus 50 db back-reflection after being fusion-spliced to cable strands in field; similar to factory-manufactured pre-terminated single-mode pigtail assemblies type SC-ultra-PC by Corning Cable Systems, Fiberall Corp. or Fiberdyne Labs, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions (by installer): Examine conditions under which computer network and related components are to be installed and notify Prime Contractor in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

1. Visit site to identify and become familiar with existing field conditions.
2. Verify all dimensions in field and confirm condition of existing hardware to be re-used.

3. Confirm space requirements and physical confines of all work areas to ensure all materials can be installed in spaces indicated.

3.2 PREPARATION

A. Protection: Provide adequate protection of equipment before and after installation.

3.3 INSTALLATION

A. Provide and install all components necessary to install complete network cabling system, including (but is not limited to) connectors, patch cables, terminations, etc.

B. Secure all horizontal cables within ceiling cavities to building structure.

1. Loosely bundle all cables and support from structure at 5 ft. intervals 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 of cable tray) as indicated on Drawings.
2. Do not support cables from ceiling grid T-bars or grid support wires or bridle rings.
3. Do not allow cables to rest on ceiling grid.
4. Install cables in conduit in all unfinished, exposed areas, including, but not limited to, storage rooms, mechanical areas, etc.
5. Do not secure cables with tightened cable-ties or any other device that deforms cable jacket.
6. Provide 6 inches slack at station termination and 24 inches slack at patch panels.
7. Place wire in conformance with EIA/TIA Standard 568A and BICSI standard.
8. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing. Replace any tautly cables/pairs. Remove all defective cables from pathways.

C. Wall outlet plates shall be installed on deep 4" square boxes with single gang plaster rings. Provide conduit from box to above the ceiling.

D. Determine allowable cable placement proximity to other electrical power sources of 480 volts or less using EIA-569 Cabling Pathways Standard to UTP cable separation guidelines from EMI sources as follows:

1. Minimum Separation Distance from Power Source at 480v or less

	CONDITION	<2kVA	2-5KVA	>5KVA
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 grounded metal conduit pathway.	3 in.	6 in.	12 in.
c.	Power lines enclosed in a grounded metal conduit (or equiv. shielding) in proximity to grounded metal conduit pathway.	3 in.	6 in.	12 in.
d.	Transformers & electric motors	40 in.	40 in.	40 in.
e.	Fluorescent lighting	12 in.	12 in.	12 in.

E. Install all cable in accordance with all National, State and Local Codes and both TIA/EIA and BICSI standards and practices.

1. Follow manufacturer's guidelines and requirements for all cable termination.
2. Install and connect #6 AWG or larger ground wires to bond all equipment racks and cabinets to building ground per EIA/TIA 607.
3. 30-inch aisle clearance both in front and rear of equipment rack for access to equipment.

F. Properly terminate all cables at each outlet location and at each Distribution Rack. Permanently identify all cables in all pull boxes, in wiring gutters and at each termination point with pre-marked self-adhesive wrap around markers similar to Brady "B-500+ Plastic Cloth Markers".

G. Permanently identify all system components using the following identification format:

1. Cable Labels: Permanently mark all cables in accordance with the following scheme and indicate distribution rack, patch panel and patch panel port numbers for each cable.

   a. Example: Cable labeled "01A35" indicates:

      1) Distribution Rack #01
      2) Patch Panel #A
      3) Patch Panel Port #35

2. Faceplate Labels: Match cable label and permanently affix to faceplate; handwritten or 'Dymo' type labels not acceptable.
3. Obtain Owner's and Architect's approval of any deviation from proposed identification scheme prior to installation. Refer to "Cable Identification Nomenclature Legend" on Drawings. Confirm and submit complete cabling schedules to Owner for final approval prior to installation.
4. Provide typed or printed Cable ID-to-Room reference chart mounted in clear plastic pouch on each data cabinet with additional copy provided to Architect.

3.4 FIELD QUALITY CONTROL

A. Network Infrastructure Testing: Provided by Contractor.

1. Perform all testing under direct supervision of manufacturer's representative or accredited agencies for all specified equipment and services. Notify Architect and Owner in writing at least 3 working days prior to time testing is to begin. Architect and/or Owner reserves the right to have representatives present and participating in testing. Provide re-testing at Contractor's expense if proper written notification above is not given.
2. If testing provided by third-party, Contractor may provide additional testing required to meet specified requirements or as desired. Notify Architect and Owner in writing at least 14 working days prior to start of additional testing. Architect, Contractor and Owner reserve the right to have representatives present and participating in testing.
3. Test entire network cabling system in presence of Owner's representative and issue report to Architect stating that cabling system is in proper operating condition and meets all manufacturer's minimum listed specifications for signal levels and data speeds.
4. Category 6, Copper UTP Testing Procedures – Includes (but not limited to):

a. Testing each copper pair with equipment similar to Microtest Omni Scanner in accordance with EIA/TIA TSB-95 Transmission Performance requirements, testing each pair from both ends and not exceeding 90m cable length.

1) Only “PASS” results acceptable; “*PASS” (modified standard) not acceptable.
2) Properly set all testing parameters for type of cable being tested and equipment used to perform tests.

b. Verifying all terminations pass wire map, length, attenuation, NEXT loss, resistance, Impedance Capacitance, Power Sum and ACR, and meet or exceed current EIA/TIA TSB-95 and BICSI standards. Provide record of test results to Architect.

c. Test Results: Provide results on CD Rom with all software required for viewing compatible with all IBM PC compatible computers and 1 printed copy for archival purposes. Include cable ID and test results for each cable in each test result table.

5. Report: Submit written test report from authorized representative of equipment manufacturer indicating that system has been tested and is in working order prior to final inspection.

3.5 ADJUSTING / CLEANING

A. Clean up debris from installation on daily basis.

END OF SECTION

SECTION 27 4134

TELEVISION DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 and Division 16 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Television distribution systems using cable television service as the signal source.
2. Broadband coaxial cabling for distributing television signal to interface points.

B. Related Sections

1. Section 270526.

1.3 DEFINITIONS

A. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. dBmV = 20 log 10(V_1/V_2) where V_1 is the measurement of voltage at a point having identical impedance to V_2 (0.001 V across 75 ohms).

B. Headend: The control center of the television distribution system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points.

C. CATV: Cable television; a small distribution system.

D. RF: Radio frequency.

E. User Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the 75-ohm terminals on device plates.

1.4 SYSTEM DESCRIPTION

A. System shall consist of cable television service and a coaxial cable distribution system.

B. Headend equipment shall consist of signal amplification, selective channel equipment, local origination and modulation.

C. Distribution of cable television service signals, which includes coordinating with Owner's selected service provider for installation of cable to the service point ready for connection into the distribution system. Obtain signal levels, and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.

D. Cable distribution system consisting of coaxial cables, user interfaces, signal taps and splitters, RF amplifiers, signal equalizers, power supplies, and required hardware complying with IEEE 802.7 and resulting in performance parameters specified in this Section. System shall be capable of distributing television channels as follows, according to EIA 542:
   1. 60 CATV Channels 2 through YY (61) low, mid, high, super, and ultra band.

E. Hardware Requirements: Use modular, plug-in, solid-state electronic components. Mount amplifiers and other powered equipment on painted, wall mounted plywood, or into an equipment rack.

F. Provide televisions including all required mounting equipment as specified herein.

1.5 PERFORMANCE REQUIREMENTS

A. Minimum acceptable distribution system performance at all user-interface points shall be as follows:

   1. RF Video Carrier Level: Between 3 and 12 dBmV.
   2. Relative Video Carrier Level: Within 3 dB to adjacent channel.
   3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minute period.
   4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.
   5. Channel Frequency Response: Across any 6-MHz channel in 54- to 220-MHz frequency range, referenced to video, signal amplitude shall be plus or minus 1 dB, maximum.
   6. Carrier-to-Noise Ratio: 45 dB or more.
   7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
   8. Cross Modulation: Less than minus 50 dB.
   9. Carrier-to-Echo Ratio: More than 40 dB.
   10. Composite Triple Beat: Less than minus 53 dB.
   11. Second Order Beat: Less than minus 60 dB.
   12. Terminal Isolation from Television to Television: 25 dB, minimum.
   13. Terminal Isolation between Television and FM: 35 dB, minimum.
   14. Hum Modulation: 2 percent, maximum.
   15. RF FM Carrier Level: 13 to 17 dB below video carrier level.
   16. FM Frequency Response: More than the 88- to 108-MHz frequency range, signal amplitude is plus or minus 0.75 dB, maximum.
   17. FM Carrier-to-Noise Ratio: More than 24 dB.

1.6 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for television equipment.

1. Include plans, elevations, sections, details, and attachments to other work.
2. For coaxial cable, include the following installation data for each type used:

    a. Nominal OD.
    b. Minimum bending radius.
    c. Maximum pulling tension.

3. Functional Block Diagram: Show single-line interconnections between components for headend and distribution system to user-interface points. Show cable types and sizes.
4. Dimensioned plan and elevations of headend equipment. Show access and workspace requirements.
5. Wiring Diagrams: Power, signal, and control wiring; and grounding.
6. Design Calculations: Calculate signal attenuation budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that proposed system layout can be expected to perform up to specification. Calculate signal strength from sources to headend input points for each antenna and CATV grouping. Allowable losses between components and User Interface shall be used to determine size and type of coaxial cable.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add testing record of each piece of adjustable equipment, listing name of person testing, date of test, and description of as-left set points.

D. Source quality-control test reports on coaxial cable sweep tests.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For headend and distribution system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.
2. Include dimensioned plan and elevation views of components and enclosures. Show access and workspace requirements.

G. Full size, for each outlet and finish plate, for colors and textures required.

1.7 QUALITY ASSURANCE

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

B. Comply with NECA 1.

C. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: System components shall be equipped and rated for the environments where installed.

B. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 1 enclosures.

1.9 COORDINATION

A. Coordinate size and location of raceway system, and provisions for electrical power to equipment of this Section.

B. Coordinate Work of this Section with requirements of direct cable television service provider.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SYSTEMS REQUIREMENTS

A. Components: Modular plug-in, heavy-duty, industrial- or commercial-grade units.

B. Equipment: Silicon-based, solid-state, integrated circuit devices.

C. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130 V.

D. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for the purpose. Comply with Division 26 Section "Transient Voltage Suppression."

E. Provide ac-powered equipment with integral surge suppressors, complying with UL 1449.

F. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

2.3 CATV EQUIPMENT

A. Description: Signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring. System shall receive signals from sources, amplify and process them, and distribute them to outlets for receiving sets.

B. Identification of Signal Sources and Channels Distributed:

1. Cable Company.

C. CATV System Qualitative Performance Requirements: Reception quality of color-television program transmissions at each system outlet from each designated channel and source shall be equal to or superior than that obtained with performance checks specified in Part 3 "Field Quality Control" Article, using a standard, commercial, cable-ready, color-television receiver.

D. CATV System Quantitative Performance Requirements: Level and quality of signal at each outlet from each designated channel and source shall comply with Specifications below when tested according to 47 CFR 76.

2.4 CATV HEADEND COMPONENTS

A. Manufacturers:

1. Blonder Tongue Laboratories, Inc.
2. Jerrold.

B. There shall be broadband distribution for distributing cable channels to outlets located throughout the facility. The outlets in the waiting area are to receive only selected channels as specified below.

C. Headend Equipment: Headend component performance specified in this Article is minimum acceptable; better performance may be required to meet minimum acceptable system performance standard in Part 1.

1. Broadband amplifier for receiving cable signals and outputting the signals to cable distribution system. Mount Amplifier on plywood backboard.

a. Frequency Range: 54 to 1000 MHz.
b. Frequency Response: Plus or minus 1.0 dB across passband.
c. Maximum Noise: 10 dB.
d. Minimum Return Loss: 16 dB.
e. I/O Impedance: 75 ohms.

2.5 DISTRIBUTION COMPONENTS

A. Manufacturers:

1. Blonder Tongue Laboratories, Inc.
2. Jerrold.

B. Distribution components shall be for signal processing and distribution downstream from headend equipment.

C. Signal Power Splitters and Isolation Taps: Metal-enclosed directional couplers with brass connector parts. Where installed in signal circuits used to supply cable-powered amplifiers, power throughput capacity shall exceed load by at least 25 percent.

1. Return Loss: 17 dB.
2. RFI Shielding: 100 dB.
3. Isolation: 25 dB.
4. Impedance: 75 ohms for input and output terminals.
5. Electrically powered components shall be UL labeled.

D. Attenuators: Passive, or fixed value, used to balance signal levels.

E. Terminating Resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.

F. User-Interface Device: Flush, female-type outlets, designed to mimic power duplex outlet, for mounting in standard outlet box, with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semirecessed so its protrusion is flush with the plane of device plate. Feedthrough-type cable connection shall not be used.

1. Cable Connector: Female, Type F.
2. Wall Plates: Match materials and finish of power outlets in same space.
3. Attenuation: Less than 0.1 dB.
4. Voltage Standing-Wave Ratio: Less than 1.15 to 1.

2.6 CABLES

A. Manufacturers:

1. Belden Inc.; Electronics Division.
2. CommScope Properties, LLC.
3. Helix/HiTemp Cables, Inc.; Draka USA.
4. West Penn Wire/CDT; a division of Cable Design Technologies, Inc.

B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband CATV applications. Cable shall be plenum rated. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB minimum from 7 to 1000 MHz, and shall be listed to comply with NFPA 70, Articles 810 and 820.

C. RG-6/U, Indoor Cable: No. 18 AWG, solid, copper-covered steel conductor; gas-injected foam-PE insulation. Quad shielded with 100 percent aluminum-foil shield, 60 percent aluminum braid, 100 percent aluminum-foil shield and 40 percent aluminum braid jacketed with PVDF. Suitable for indoor installations; NFPA 70, Type CATV or CM.

D. RG-11/U, Indoor Cable: No. 14 AWG, solid, copper-covered steel conductor; gas-injected foam-PE insulation. Quad shielded with 100 percent aluminum-foil shield, 60 percent aluminum braid, 100 percent aluminum-foil shield and 40 percent aluminum braid jacketed with PVDF. Suitable for indoor installations; NFPA 70, Type CATV or CM.

E. Cable products shall be sweep tested at the factory before shipping at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

2.7 TELEVISIONS

A. Provide the following wall plates, interconnection cables and patch cables at each wall mounted television location.

1. Plates located behind the television and below 40” AFF shall be as follows:
   a. Basis of design is from Cables To Go
   b. 2 gang plate 42100
   c. HD 15 VGA connector
   d. 3.5mm audio
   e. L&R RCA audio
   f. RCA composite video
   g. 42419 HDMI insert
   h. 03824 F connector insert
2. Interconnecting cables.
   a. 42401 RapidRun cable
   b. 42135 RapidRun cable
   c. 41180 RapidRun cable
   d. 40750 RapidRun cable
3. Cables from plate to television
   a. 52128 UXGA + 3.5 mm audio
4. Distribution wall plate behind the television
   a. F connector from CATV distribution
   b. RJ45 Cat 6 connector wired to nearest tele/com room

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for coaxial cable installation. Check raceways, cables, trays, and other elements for compliance with accessibility for installation and maintenance, and other conditions affecting installation.

B. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where television equipment is to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install signal line surge suppressors on coaxial cables entering headend equipment.

B. Provide power for the installed televisions and headend.

3.3 GENERAL WIRING

A. Wiring Method: Install cables in raceways except in accessible indoor ceiling spaces, attics, in hollow gypsum-board partitions, and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.

B. Wiring Method: Install cables concealed in accessible ceilings, walls, and floors where possible.

C. 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.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Grounding: According to recommendations in IEEE 142 and IEEE 1100.

3.4 COAXIAL CABLE INSTALLATION

A. Cable may not be installed in same raceway with power cable.

B. Coaxial cable shall not be spliced except on plywood backboards in wire closets, or in cabinets designated for the purpose.

C. Do not use water-based cable pulling lubricants with PVC-jacketed cable.

D. Do not exceed manufacturer's recommended minimum bending radiuses

E. Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. 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.

F. Exposed Cable: Install parallel to building lines, follow surface contours, and support cable according to manufacturer's written instructions. Do not run adjacent and parallel to power or data cables.

G. Cable Support: Install supports at intervals recommended in writing by cable manufacturer. Install supports within 6 inches of connector so no weight of cable is carried by connector. Use no staples or wire ties, pull tie-wrap snug, and do not over tighten.

H. Signal Equalization: Where system performance may be degraded in certain operating modes, revise component connections and install distribution amplifiers and attenuators as required, providing a balanced signal across the system.

I. Install passive circuit devices, such as splitters and attenuators, in wire closets or cabinets. Do not install attenuators as part of user-interface device outlets.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Test Schedule: Schedule tests after pretesting has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

D. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Distribution System Acceptance Tests:

1. Field-Strength Instrument: Rated for minus 40-dBmV measuring sensitivity and a frequency range of 54 to 812 MHz, minimum. Provide documentation of recent calibration against recognized standards.
2. Signal Level and Picture Quality: Use a field-strength meter or spectrum analyzer, and a standard TV receiver to measure signal levels and check picture quality at all. User-interface outlets.
   a. Test the signal strength in dBmV at 55, 151, 547, and 750 MHz.
   b. Minimum acceptable signal level is 0 dBmV (1000 mV).
   c. Maximum acceptable signal level over the entire bandwidth is 15 dBmV.
   d. Television receiver shall show no evidence of cross-channel intermodulation, ghost images, or beat interference.
3. Signal-to-Noise-Ratio Test: Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed-on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set must not be less than 45 dB.

F. Record test results.

G. Retest: Correct deficiencies identified by tests and observations and retest until requirements specified in Part 1 are met.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain CATV equipment.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Demonstrate programming and tuning of satellite receivers.
4. Refer to Division 1 Section "Demonstration and Training."

B. Conduct a minimum of two (2) hours training as specified in instructions to Owner's employees in Division 1 Section "Closeout Procedures."

END OF SECTION

SECTION 27 5116

PUBLIC ADDRESS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of Division 26 and Specification section 275123 apply to this Section.

1.2 SCOPE OF WORK

A. General:

1. Provide a complete Zoned Public Address System (PS) including amplifiers, control equipment, speaker assemblies, cabling, etc. for a fully operational public address system.
2. The system shall be a multi-function, announcement system. Microprocessors and appropriate digital processing shall control the system's operation and controls.
3. The system shall be capable of control of all functions and hardware including:
   a. Microphone page stations, associated routing and priority structure.
   b. Telephone page interfaces.
   c. Distribution of emergency announcements.
   d. Distribution of general announcements.
   e. Distribution of background music and other audio sources.
   f. Monitor/test/supervision functions.
   g. Ambient noise analysis functions.
   h. Logic and voltage control interfaces to other systems.
   i. Computer network interface.

1.3 SYSTEM DESCRIPTION

A. General

1. The digital paging system shall be a complete system for amplifying sound signals from microphones and program sources and distributing them to loud speakers at various locations. The system is based on a Biamp AudiaFusion Networked Paging System. Other acceptable manufacturers are IED or Bosch provided they meet the specifications.
2. The Fusion Paging system is an integrated audio communication system based upon PC equipment and Biamp professional audio hardware and software.
3. The system utilizes a central head-end for system control. The central head-end controls the distribution of announcements.
4. The Fusion Paging System shall support and distribute digital audio via CobraNet technology for paging stations, message queuing, emergency announcements, local announcements, and background music.

B. Redundancy

1. The Fusion Paging Systems shall support amplifier monitoring, failover, and failback to one secondary amplifier channel. During a failover event, the System monitors the secondary channel as it actively powers the zone. Additionally, alerts for failure events shall be sent via e-mail with details of the event including device name, location, amplifier channel and the system conditions which caused the system to fail over.

C. Zones

1. The Fusion Paging System shall be capable of assigning any paging station to any paging zone(s) without hardware changes.
2. The System shall be capable of dynamically grouping paging zones without hardware changes.
3. The initial System shall be configured for eight (8) channels, but shall not be constrained to the number of zones that may be created.
4. Zones are named and presented to users with descriptive alphanumeric names.
5. Zones shall be as follows

    a. Shop and bays.
    b. General Maintenance
    c. Fueling/Wash.
    d. Admin.
    e. Parts.

D. Diagnostics

1. The Digital Paging System shall be capable of monitoring critical system information for hardware device including amplifiers, and short circuit in output.

E. Paging Stations

1. The Networked Paging Station shall control the System through a scroll wheel and three (3) push buttons.
2. The Stations shall be located as shown on the drawings.

    a. Reception

F. Ambient Noise Compensation

1. The Networked Paging System shall provide for ambient noise compensation that allows users to adjust playback volume up or down based upon the level of ambient noise. Ambient noise adjustment is handled in one of three ways:

    a. Automatic ambient noise analysis compensation via ambient noise sensing shall sense via single or multiple microphones. Multiple sensing microphones within a given zone that has varying ceiling heights has sensitivity and mixing adjustments on each microphone channel. Ambient noise sensing controls amplified SPL levels by independent zones based on a time and frequency weighted averaging of ambient noise within any given zone area. Time and frequency weighting are user selectable.
    b. The Bay zone shall be equipped for this feature.

G. Provide new speakers and cabling as shown on the plans.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 and 26 Specification Sections.

B. Shop Drawings: Submit complete sets of shop drawings including:

1. Manufacturer's product data for each type of product specified.
2. Details of the public address system including, but not limited to the following:
   a. Rack layouts
   b. Input stations
   c. Amplifier sizing calculations
   d. Dimensional information
   e. Submit scale system layouts using the architectural floor plans to show cable types, zone configurations, equipment locations, etc.
   f. Block diagrams showing major components and interfaces.
3. Wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer installed wiring and field wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation and maintenance. Identify wiring to other systems.

C. Record Documents

1. Provide record documents in accordance with Divisions 1 and 26 Specification Sections.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturers regularly engaged in the manufacturer of professional quality public address systems, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Supplier's Qualifications:

1. Supplier shall be an experienced product supplier who is the factory authorized sales and service representative for the manufacturer, who is regularly engaged in the design and installations of such systems, and can oversee the installation, trouble shooting and final connections.
2. The supplier shall be located within 50 miles of the installation site.
3. Supplier shall have represented the manufacturer of the system and components being installed for at least 5 years.
4. The supplier shall have a minimum of 2 factory certified technicians. Copies of the certifications shall be included with the submittals.

C. Installer Qualifications:

1. Installer shall have at least 5 years experience installing public address systems similar to the system specified here.
2. Refer to Division 1 Section "Definitions and Standards" for definition of experienced installer. Upon request, provide evidence of such qualifications to the Engineer.

D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70.

E. All system and components shall be Underwriters listed and labeled.

F. Compliance: System and components shall comply with the following standards:

1. Sound Systems, EIA-160.
2. Loudspeaker, Dynamic Magnetic Structures and Impedance, EIA-299-A.
3. Racks, Panels, and Associated Equipment, EIA-310-A.
4. Amplifiers for Sound Equipment, SE-101-A.
5. Speakers for Sound Equipment, SE-103.
6. Microphones for Sound Equipment, SE 105.
7. Requirements of UL 50.

G. Warranty

1. The system shall be covered by a one (1) year labor warranty from the date of acceptance.
2. All components of the manufactured sound system shall be warranted for 5 years from the date of acceptance.
3. All other components shall be warranted for one (1) year from the date of acceptance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.7 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide amplifiers that are listed on the U.S. Department of Energy's ENERGY STAR Qualified Product List.

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT

A. RACK ENCLOSURE: All rack-mount Paging System (PS) equipment shall be housed in EIA standard 19” equipment enclosure. The rack shall be wall-mounted.

1. Adequate ventilation shall be supplied for the rack, and temperatures at all critical components shall not exceed 95 degrees F. Convection or forced-air cooling may be used, as long as this heat threshold is not surpassed, regardless of external factors. System components featuring internal forced-air cooling shall be provided adequate hot air extraction through the rear of the enclosure.
2. The rack shall be constructed of 16 gauge steel with 14 gauge steel mounting rails. All joints shall be welded and bonded.
3. The height of each rack shall be as required for the specified equipment, plus 25% spare space for future growth.

4. Blank panels shall be provided to fill all unused rack space.
5. Acceptable rack manufacturers:
    a. Great Lakes
    b. Middle Atlantic
    c. Atlas Sound
    d. Lowell

2.2 NETWORKED AMPLIFIED PROCESSOR

A. The Networked Amplified Processor shall be an integration if DSP, multi-channel amplifiers and load monitoring.

B. The amplifier shall be rack mountable (3RU) and feature software-configurable signal processing (DSP), including volume control, filters, compressor/limiting, delay, speaker equalization, and output sensitivity.

C. The amplifier shall be modular and support software configurable power levels/load options of 8 amplification modules per frame with 100 to 600 Watts per module (maximum of 2400W per chassis) and 70V or 100V with direct drive capability, or low-impedance (4 or 8Ω) operation.

D. The amplifier shall provide control data and digital audio over CobraNet®. The amplifier shall provide dual CobraNet ports for redundant network connection.

E. The amplifier shall provide front-panel LED identification:

1. Amplifier and card failure
2. Signal present
3. Clip present
4. Fan stuck-rotor fault
5. Heat sink temperature fault
6. Additional software monitoring features including short circuit on output fault.

F. The amplifier shall support channel-to-channel and chassis-to-chassis failover.

G. The amplifier shall be CE marked, UL listed and shall be compliant with the RoHS directive.

H. The modular amplifier shall be programmed using Biamp® Audia® configuration software

I. The amplifier shall be an AudiaFUSION.

J. Minimum Specifications

1. Inputs
    a. 20bits
    b. 48 kHz
    c. Supported CobraNet
    d. Latency 5-1/3, 2-2/3, or 1-1/3
    e. Software configurable

2. Outputs
    a. 4 or 8 ohm, 70 or 100 volt line direct

b. 1 kHz continuous sine wave indefinitely
c. Frequency Response: 20 Hz-20 kHz (+/-1db)
d. THD+N: <0.3% (20 Hz-20 kHz) at all power levels
e. IM distortion: <0.2%
f. Inter-channel Isolation: .-75dB(20Hz – 2kHz, full power out)
g. DC offset: <10mV

3. Connections

a. RJ45 (CAT 6)

2.3 NETWORKED PAGING STATION

A. The networked paging station shall be designed for use with AudiaFUSION systems.

B. The networked paging station shall provide paging audio and control data via CobraNet®, and receive Power-Over-Ethernet (PoE), utilizing a single (CAT6) network cable to a rear panel RJ45 connector.

1. Use of an external power supply shall be optional.

C. A rotary encoder and LCD screen shall be provided on the front panel for programming and setup.

D. Multiple networked paging stations shall be connected to the AudiaFUSION, by means of Ethernet switches, in either single-unit or multi-unit systems.

1. Up to 16 simultaneous pages shall be allowed per AudiaFUSION unit.
2. Up to 16 paging priority levels shall be available, including override and lock-out capabilities.
3. Each networked paging station shall have up to 32 programmable button operations assignable, and multiple announcement chime tone options shall be available.
4. Networked paging stations shall be represented as functional blocks within Audia® software, which shall also include dedicated page zone routing blocks, for easy inclusion into system designs.

E. The networked paging station shall be CE marked and shall be compliant with EU Directive 2002/95/EC, the RoHS directive.

F. Minimum Specifications:

1. Frequency Response: 150 Hz – 20 kHz +/-2dB
2. Gain: 6dB ~ 36bB selectable in 10dB steps
3. Maximum Input: 115dB SPL
4. Microphone type: Electret condenser
5. Microphone pattern: Cardioid
6. A/D Converters: 24 bit, 48 kHz
7. Power: 802.3af (POE) Class 1 12-24 VDC, 3 W

G. The networked paging station shall be a Networked Paging Station-1.

2.4 INPUT/OUTPUT EXPANDER

A. Provide two (2) I/O expanders to accept the ambient noise sensing microphones and theCD/Tape inputs.

B. The Input/Output Expander shall provide two mic/line analog audio inputs and two line-level mic pad analog audio outputs.

1. Specifications

a. Front-panel level control and peak indicators shall be provided for adjustment of the analog audio input signals.
b. Front-panel level control shall be provided for adjustment of the analog audio output signal.
c. Internal analog-to-digital and digital-to-analog signal conversions shall be 24-bit, with a sample rate of 48kHz.
d. Two channels of digital audio output and two channels of digital audio input shall be provided via CobraNet on a front-panel RJ45 connector.
e. The Input/Output Expander shall provide IEC 1938-compliant 48VDC Phantom Power on each input.
f. A rotary encoder and LCD screen shall be provided on the front panel for level setting, programming and setup.
g. The Input/Output expander shall be powered by IEEE-standard 802.3af Power-over-Ethernet as a Class 3 device.

1) Optionally, it can be powered from an external +18-24VDC @ 13W Class-III power source

h. The Input/Output Expander shall be represented as a functional block within Audia® software, for easy inclusion into system designs.

C. The Input/Output Expander shall be CE marked and shall incorporate AES48-2005 Grounding & EMC practices.

D. The Input/Output Expander shall be compliant with EU Directive 2002/95/EC, the RoHS directive.

E. The Input/Output Expanders shall be AudiaEXPI/O-2.

2.5 AMBIENT NOISE COMPENSATION

A. The networked digital paging system shall use remote microphones in the system to sense the ambient noise that provides this information back to the internal digital signal processing system. The programming in the DSP shall provide the ambient noise compensation capability for the system.

B. Provide two (2) AKG PZM-11LL ambient noise sensing microphones strategically located throughout the bays. The DSP will provide real time zoned ambient noise compensation capability for the system based on the amount of ambient noise present in the facility.

C. The time and frequency weighted algorithm in the DSP's advanced ambient noise compensation module accurately distinguishes between the ambient noise in the facility and the actual program material whether it is a live announcement, message, or background music. The

processing of the DSP allows the system to remove the content of the actual announcement or other program material from the ambient noise signal that is sensed by the microphones in the facility. This process allows the true ambient noise in the facility zones to be read by the DSP allowing real time level control and preventing the system from runaway gain or "looping" on itself.

1. Adjustable software parameters for the ambient noise compensation include Ambient Threshold, Ratio, Attack, Release, and Minimum and Maximum Level control. The software also provides Time or Schedule-based ambient noise compensation allowing for different volume adjustment parameters within any zone based upon user defined schedule.

D. The ambient noise sensing microphone shall be the AKG PZM-11LL.

2.6 FACILITY INFRASTRUCTURE REQUIREMENTS

A. Network Configuration

1. The networked digital paging application can run on several different local area network configurations.
   a. CobraNet Enabled Network
      1) VLAN (100/1000 MB)
      2) Isolated network (100/1000 MB)
   b. Non-CobraNet Enabled Network
      1) 100 MB Network

B. The Digital Paging application requires Quality of Service be enabled.

C. Cable Specifications

1. Local Area Network (LAN) data cable
   a. Category 6, 4 pair, plenum rated data cable
   b. Refer to section 275123
   c. Must comply with IEEE standards for installation.

2. Loudspeakers cable
   a. All speakers indicated by a group zone number on the drawings shall be wired in parallel in a daisy-chain configuration to its amplifier channel by a single cable run.
   b. All speaker lines shall be spliced in junction boxes only.
   c. UL listed 18 AWG minimum stranded copper conductor with CL3 approved rating.
   d. Plenum rated where applicable.
   e. Each cable shall be a twisted pair with overall plenum rated jacket.
   f. Manufacturer: Belden type 6000 UE or approved equal.
   g. All cables are to be installed in conduit.

3. Paging Station cable

a. A single strand of data cable (see Local Area Network (LAN) data cable description above) shall be wired in a single continuous run and to the nearest communication room or network switch location and properly terminated.
b. Category 6, 4 pair, plenum rated data cable.

4. Ambient Noise Microphone cable

a. Single or dual pair of 18 to 22 gauge stranded tinned copper wire signal conductors with polyethylene insulators, with equal size and type drain wire with 100% overall foil shield in overall insulator.
b. All ambient noise microphone wire runs shall be continuous run from the paging station location to its input stage with no line splices.
c. Meet IEEE & AES standards
d. All cables are to be installed in conduit.
e. Plenum rated, where applicable
f. NEC type CM or C2 rated
g. UL rated
h. Manufacturer: West Penn 291 (or approved equal)

2.7 NETWORK SWITCHES

A. General

1. Provide Ethernet, 10/100/1000 switch to network the digital paging components together.
2. Provide a Cisco layer switch or equal.

B. Rack Mount Switch

1. Provide one (1) switch, one in the paging rack.
2. Switch shall have the following features:

a. Ethernet 10/100/1000
b. 24 port
c. 4 Gigabit SFP ports
d. POE+ (740W)
e. Integrated security to protect network traffic and to limit access.
f. Network Monitoring capabilities and enhanced troubleshooting for connectivity issues.
g. SNMP
h. USB storage for file backup and simplified operations
i. QOS

3. Provide the required transceivers
4. Provide any required licenses
5. Switches shall be Cisco WS-C2960S-24FPS-L or equal

2.8 CD/TAPE and SPEAKERS

A. CD/TAPE

1. Provide Tascam CDA 500 CD/Cassette
2. Integrated CD Player/Reversible Cassette Deck

3. 3-U rack-mount design
4. RCA unbalanced outputs common for both cassette deck and CD player
5. RCA unbalanced outputs dedicated to the CD player
6. ±12% pitch adjustment on cassette deck
7. Wireless remote included
8. CD sync feature
9. Continuous play function between cassette and CD

B. Speaker systems for acoustic tile recessed round baffles shall be:

1. Speaker shall be Lowell 810 dual cone.
2. Frequency response: 45Hz – 13kHz, +/-6dB
3. Power capacity: 15W
4. Sensitivity: 95dB SPL, 1W, 1m
5. 10oz. magnet
6. Autotransformer taps: 1, 2, 4, 8 W
7. Speaker baffle shall be Lowell CN-8M.
8. Backcan shall be Lowell IX810.
9. Bridge shall be Lowell LBS8-R1.
10. Baffle shall be paintable with color as selected by the Architect.

C. Speakers system for recessed wall baffles (SP4) shall be:

1. Speaker shall be Lowell 810 dual cone.
2. Frequency response: 45Hz – 13kHz, +/-6dB
3. Power capacity: 15W
4. Sensitivity: 95dB SPL, 1W, 1m
5. 10oz. magnet
6. Autotransformer taps: 1, 2, 4, 8 W
7. Speaker baffle shall be Lowell FW-8T.
8. Backcan shall be Lowell RE-1175T.
9. Baffle shall be paintable with color as selected by the Architect

D. Exterior mounted speaker shall be:

1. Speaker shall be Lowell LUH-15T.
2. Re-entrant horn.
3. Frequency response: 740Hz – 7.4kHz, +/-5dB
4. Power capacity: 15W
5. Sensitivity: 105dB SPL, 1W, 1m
6. Autotransformer taps: .9, 1.8, 3.8, 7.5, 15W
7. Back box shall be Lowell LUH-BOX

E. Mechanical rooms / shops / Bays, etc. speakers shall be:

1. Speaker shall be Lowell LH-15T.
2. Re-entrant horn.
3. Frequency response: 650Hz – 4.6kHz, +/-5dB
4. Power capacity: 15W
5. Sensitivity: 106dB SPL, 1W, 1m
6. Autotransformer taps: .9, 1.8, 3.8, 7.5, 15W

PART 3 - EXECUTION

3.1 QUALITY CONTROL

A. All components of the public address system as a whole shall meet or exceed the minimum standards issued by the EIA. All work in conjunction with this installation shall meet the requirements of the National Electrical Code.

B. The Contractor shall provide necessary transient protection of the AC power feeding the paging system. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

3.2 INSTALLATION, WIRING AND RACEWAY

A. Preparatory work required to accommodate the public address system installation, i.e., conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required, shall be furnished and installed by the Contractor.

B. The public address system supplier shall provide expert supervision of the installation and in addition, shall furnish the necessary wiring diagrams and instructions required to make the final system installation complete.

C. The installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

D. The Contractor shall make installation in strict accordance with approved manufacturer's drawings and instructions.

E. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Architect/Engineer.

F. All equipment power wiring and grounding shall conform to the National Electrical Code and applicable local codes.

G. All electronic equipment shall be grounded.

H. All cable shall be adequately supported and connectors specifically designed for the type cable in use.

3.3 WIRING

A. The Contractor shall furnish and install all wiring, conduit, back-boxes, pull boxes, outlets and boxes for the erection and operation of a complete public address system as specified and described in these specifications, as shown on the drawings and recommended by the manufacturer.

B. All equipment power wiring shall be of the same type for lighting and power. Wiring shall meet the requirements of the National, State and local electrical codes.

C. All public address system cabling shall be run in conduit.

D. Speaker and Microphone Cable - Stranded tinned copper, polypropylene insulated, twisted pair, aluminum - polyester shield, 22 AWG stranded tinned copper drain wire as specified by the manufacturer.

E. Final connections between equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer of the equipment furnished. At the completion of the installation the manufacturer's representative shall test and adjust the system.

F. Network wiring shall be in accordance with Specification Section 275123.

3.4 SYSTEM TEST AND ADJUSTMENTS

A. Before final acceptance of the public address system, the manufacturer/supplier of system shall, in presence of Contractor and Owner, test each and every component and device in the system. The test shall be documented with signed copy submitted to the Contractor, Owner and Architect/Engineer.

B. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and amplifier level controls to insure proper system operation.

C. The system shall be physically inspected by the Owner's representative and the Architect/ Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.

D. The system shall be equalized using a noise generator and octave band analyzer. The settings shall be mounted inside the cabinet door and included in the maintenance manuals for future reference.

E. As a minimum requirement, the public address system should be tested to prove the following:

1. The complete system is free from grounds, opens and shorts.
2. Each device functions as specified herein.
3. Abnormal condition of any circuit or device which is to be electrically supervised shall be checked for trouble indication.
4. Proper adjustment of all speaker taps to provide clearly audible, but unobtrusive paging in all areas, to the Engineer's and Owner's satisfaction.

3.5 OWNER INSTRUCTION ON SYSTEMS OPERATION

A. Upon completion of the work, and prior to acceptance of the same by the Owner, the Contractor and the major equipment manufacturer's qualified representative shall spend a minimum two (2) hours, with the facility personnel, instructing them on the operation and service of all the public address system equipment and controls.

B. The Contractor shall properly instruct maintenance personnel to perform emergency repairs to the system such as replacement of defective standard components such as loudspeakers, etc.

END OF SECTION

SECTION 27 5123

INTERCOM 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 RELATED SECTIONS

A. Section 270256 - Communications Grounding.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 and 26 Specification Sections.

B. Shop Drawings: Submit complete sets of shop drawings including:

1. Manufacturer's product data for each type of product specified.
2. Details of the public address system including, but not limited to the following:
   a. Input stations
   b. Dimensional information
   c. Submit scale system layouts using the architectural floor plans to show cable types, zone configurations, equipment locations, etc.
3. Wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer installed wiring and field wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation and maintenance. Identify wiring to other systems.

C. Record Documents

1. Provide record documents in accordance with Divisions 1 Specification Sections.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturers regularly engaged in the manufacturer of professional quality intercom systems, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Basis of design is Commend USA

B. Supplier's Qualifications:

1. Supplier shall be an experienced product supplier who is the factory authorized sales and service representative for the manufacturer, who is regularly engaged in the design and installations of such systems, and can oversee the installation, trouble shooting and final connections.
2. Supplier shall have represented the manufacturer of the system and components being installed for at least 5 years.
3. The supplier shall have a minimum of 2 factory certified technicians. Copies of the certifications shall be included with the submittals.

C. Installer Qualifications:

1. Installer shall have at least 5 years experience installing intercom systems similar to the system specified here.
2. Refer to Division 1 Section "Definitions and Standards" for definition of experienced installer. Upon request, provide evidence of such qualifications to the Engineer.

D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70.

E. All system and components shall be Underwriters listed and labeled.

F. Compliance: System and components shall comply with the following standards:

1. EIA
2. Requirements of UL

G. Warranty

1. The system shall be covered by a one (1) year labor warranty from the date of acceptance.
2. All components of the manufactured sound system shall be warranted for 5 years from the date of acceptance.
3. All other components shall be warranted for one (1) year from the date of acceptance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM DESCRIPTION

A. The purpose of the Intercom System shall be to provide voice communication capability in "simplex", "duplex" or "full duplex" mode selectable for each subscriber separately. The system shall also provide extensive group call, all call features and pre-programmable conferences and flexible conferences with an unlimited number of subscribers in each conference.

B. The System shall be microprocessor controlled and shall incorporate modular components. All circuitry and components shall be arranged on slide-in printed circuit boards using SMD-Technology. Each module shall have its own microprocessor and a fault in one module shall not affect the function of the whole system. The modules shall have diagnostic LED's for maintenance and fault detection.

C. The system shall be able to store and distribute prerecorded audio messages. No additional third party storage device shall be required. Messages shall be synchronous/a-synchronous and programmable up to 16 kHz bandwidth.

D. This system shall provide line level audio output for integration with amplifiers-PA, telephone system, 2 way radios.

E. The system shall be able to utilize DSP (digital signal processor) technology for subscriber cards and stations (master stations and substations). It shall be possible to upgrade DSP system features by simply uploading a software upgrade without the need for hardware modifications. Field devices (stations) shall be upgradeable from any location within a networked system. Replacing of firmware chips shall not be acceptable.

F. The intercom server shall be capable of internally managing IP video streams between IP camera intercom stations and intercom master stations equipped with TFT monitors. The TFT monitors shall be either built into the intercom master station or act in conjunction with the intercom master station as a modular unit.

G. Line supervision of each station shall be possible and line failure shall be reported to predefined stations. On selected stations (with built in DSP processor) microphone/speaker supervision shall be possible to guarantee station operation and shall immediately report any failure to preprogrammed station(s). Testing interval shall be programmable from 1 minute to 15 hours.

H. The switching of the voice signals shall be digital and the system shall be capable of supporting digital (2-wire) stations. The internal processing of the voice signals shall be digital. The architecture of the Intercom System shall support digital networking of several locations by means of fiber optic, LAN/WAN/Ethernet, 2-wire HDSL or other digital transmission systems.

I. The digital networking shall provide at least 10 speech channels between centrals based on a 2Mbit data transmission rate and shall also support remote programming to any central from any central within the network.

J. Ethernet/LAN/WAN networking shall be accomplished with a plug-in networking card for direct access to a 10baseT Ethernet connection without the need of an external modem/interface. No additional programming device or software for configuration shall be required.

K. The system shall be expandable to 25,000 subscribers without restrictions in increments of four. Each central shall provide 56 digital audio lines (total non-blocking system) and 56 analog audio lines depending on the selected central model. The system shall automatically assign appropriate speech channel (analog and/or digital) for each conversation.

L. This system shall provide up to 8 simultaneous open duplex conference channels. In addition each central shall include one auxiliary external audio input and shall provide 90 group functions and (radio conference).

2.2 INTERCOM SERVER

A. System description:

1. The INTERCOM SERVER shall be fully digital, microprocessor based, modular design. All programming for each subscriber shall be possible from any central on the network or via RS-232 connection and/or IP connection.
2. In addition programming shall be possible utilizing a dial-up connection via modem (dial-up shall be password protected).
3. The configuration of the subscriber features shall be programmed via PC and stored in the internal non-volatile memory of the central – no batteries shall be required to maintain configuration programming. All software required for programming the system shall be provided as part of the central at no extra cost.
4. Subscribers can be added at any time by using additional subscriber boards in the central. Each subscriber board provides 4 subscriber ports.
   a. It shall be possible to choose subscriber feature-level (B,C,D,P) by selecting the appropriate subscriber card and license. The higher-letter include features of the lower ones plus additional features. Therefore non-required features do not have to be purchased.
   b. All subscriber cards shall be interchangeable within the system.
   c. Feature upgrade of specific stations shall be possible by license upgrade or simply replacing the subscriber card with a higher-letter card. Subscriber card shall be changeable without any re-wiring required.
5. Server shall minimally consist of the following:
   a. Commend GE800 system IP intercom server with power supply
   b. Commend G8-IP-4B subscriber board for 4 IP stations with feature level B (quantity 2)
   c. Commend L8-IP-8D License upgrade
   d. Commend L8-IP-8B License upgrade
   e. Commend G8-AUD-2B Audio interface board
   f. Commend L8-AUD-2D license upgrade
   g. Commend G8-VOIPSERV SIP server card
   h. Commend G8-VOIP-ENG engineering fee
   i. Commend G8-IAX-4B G8SIP/AX 4 trunk card
   j. Commend L8-IAX-4D License upgrade

2.3 SUBSCRIBER (STATION)

A. Basic subscriber features:

1. Each subscriber shall be capable of calling any other subscriber in the system unless restricted by programming.
2. Unless otherwise specified clear hands-free duplex conversation shall be established upon connection. “Full-Open Duplex” conversations shall be possible hands-free and without the need of handsets or gooseneck/directional/noise canceling microphones utilizing DSP stations.
3. It shall be possible to assign a subscriber dialing numbers of 1-, 2-, 3- to 8 digits in length. The system shall allow programming of direct dialing functions for each subscriber individually.
4. Dialing “00” shall initiate “All Calls”, announcements can be suspended by pressing the “T” button once. The called party may answer the call from any station by simply dialing

"TT". It shall be possible to restrict via programming any station from initiating or receiving "All Calls", "Group Calls" and/or "Conference Calls".

5. Volume control shall be programmable for each type of call for each subscriber individually. Maximum volume level for call types individually shall be assigned to subscriber via programming. Volume may be adjusted on selected models of stations by pressing the "Up" or "Down" key.
6. Personal directory of all programmed stations and features available to a specific subscriber shall be displayed via high-resolution graphic backlit TFT monitor or LCD-screen (on selected models)
7. A substation can be programmed to call a specific master station, substation or special features such as "All Call" or "Group Call".
8. Station name and/or number shown on the alphanumeric display at a master station shall identify calls, call requests, emergency calls, alarms and status of inputs.
9. It shall be possible to restrict features and dialing sequences for any subscriber individually.
10. Privacy mode may be selected by simply dialing the appropriate code at the station. This feature may be enabled/disabled individually per subscriber via programming. When in privacy mode incoming calls shall be announced by special tone, flashing red/blue/green LED or prerecorded message. Pressing any button shall start conversation.
11. Calls may be transferred from one station to a preprogrammed "Secretary Station" by simply placing the station on its side (for specific model desktop stations) or dialing the appropriate code.
12. If the called party is busy the calling station may leave a recall-request by pressing "5".
13. Once call connection is established, normal conversation shall take place in the preprogrammed mode. If desired manual control of the direction of the conversation shall be possible by pressing the "T" button (press to talk, release to listen).
14. During conversation a person shall be able to momentarily mute the microphone on any station by pressing "7". Pressing "7" again shall un-mute microphone and restore normal conversation.
15. It shall be possible to enable/disable a minute tone during conversation for each subscriber via programming.
16. Once a call is connected it shall be possible to place the call on hold by pressing "3", dialing and conversing with a third party, switching back and forth or transferring the call.
17. The system shall allow up to 8 open duplex conferences with unlimited numbers of subscribers in each group. Dialing the preprogrammed conference code shall automatically initiate the conference call, each subscriber in the group shall be able to speak to the group hands free or by holding down the "T" button on their station. Each group member shall be able to leave the conference by pressing the "X" button. Conference stations can be programmed as "listen only".
18. Additionally the system shall support up to 40 radio conferences for 2-way radio integration (up to 40 channels). Utilizing a DSP subscriber card in the system it shall be possible for master stations to listen to up to 4 radio channels simultaneously. The master stations shall be able to selectively answer to each radio channel individually. It shall be possible to adjust the volume of each selected radio channel on the master station (selected models) individually. The DSP subscriber card shall support the connection for 4 digital stations.
19. The System shall allow up to 90 programmable group calls with unlimited numbers of subscribers in each group.
20. The system shall allow up to 40 channels of music or other audio signals to be distributed up to 16 kHz audio to all programmed stations. Each Station may select the desired channel by simply dialing the channel code, volume shall be adjustable at the station

and/or programming and a maximum volume level shall be assigned via system programming. Channel shall be interrupted during intercom calls and return automatically upon completion of the call.

21. If called station is busy call-waiting feature shall be activated by pressing “0” at calling station, when the called station disconnects the call shall automatically be placed.
22. Follow-Me function may be activated by placing the station on its side (desktop stations only) or dialing the “secretary transfer code”. At the target station enter “transfer code + own station number”. Calls to station will automatically be transferred to target station.
23. Calls from stations programmed as door stations to any other programmed subscriber or group of subscribers shall be able to utilize one or more assigned relay contacts activated from the called station by pressing the preprogrammed button.
24. The system shall be able to accommodate substations with incorporated IP or analog cameras. The IP camera substations shall support POE (power over Ethernet) or have the ability to accept a local power supply. IP or analog cameras shall work with a substation either as one unit or in modular stand alone components.

B. Master Stations

1. General:

   a. A master station shall include the following back light controls; dialing button 0-9, “T’-button, “X”-button, scroll/volume up/down buttons, “Enter, Menu- button and three function keys “F1”,”F2” and “F3” (on selected models).
   b. It also shall provide a large graphic LCD-display with 8 lines x 14 characters, a single line 6-character alphanumeric display or 3.5 inch 320 x 240 pixel TFT color monitor depending on selected model. The master station shall incorporate ergonomic design, wall mount or desktop.
   c. All master stations shall have a “handset function” enabling user to switch from loud speaking operation to handset mode by simply lifting station and placing to ear (exception: desktop models with gooseneck microphone).
   d. Master station shall provide RJ-11 connector for standard CAT5-cabeling connection and shall be available in digital (2-wire), or digital-DSP (2-wire).

2. IP Version:

   a. IP version shall interface to the appropriate version of subscriber card in the INTERCOM SERVER; connection shall be established by using 1 Network cable to the LAN/WAN.
   b. It shall be possible to connect any associated master station (digital or analog), with the use of the IP adapter, directly to an network with static or dynamic IP address, with no limit or compromise to station audio quality or function. Master stations shall also be capable of directly connecting to a network with static or dynamic IP address, with no limit or compromise to station audio quality or function. In addition, due to the DSP functionality of the IP Adapter, all analog stations connected via IP Adapter shall have all DSP functions normally associated with Commend Digital/DSP stations. These functions include Full Open Duplex communication, with or without gooseneck microphone or handset, integral audio threshold monitoring and speaker and microphone monitoring.
   c. Versions of IP master shall include: any station in the manufacturer’s intercom station range. Large graphic LCD-Display (8 lines x 14 characters) or 3.5 inch 320 x 240 pixel TFT color monitors shall be available on selected digital models.

"Full-Open Duplex" hands-free conversation shall be possible on all analog and digital stations without the need of gooseneck/directional/noise canceling microphones or handsets.

d. Stations shall provide an integrated 2.5W class "D" amplifier for use with optional attachable loudspeaker. Desk master station shall provide connector for external headset.

e. As an option, a two input / output plug in board shall be available in addition to the contact closures and inputs found on various models of intercom station.

f. Firmware/feature upgrades shall be made available via download through the intercom server over the IP network. No local modification on the station shall be required.

g. Station shall incorporate high sensitive microphone to provide clear conversation from a maximum range of at least 23 ft. Microphone sensitivity levels shall be adjusted between +12 and -21 dB via CCT configuration software.

h. The minimum frequency range shall be 200-16000Hz

i. Network Requirements.

(1) Bandwidth requirement 146 Kb/s per active conversation.

(2) Network latency 100ms (Max) 10/100 Full duplex.

j. Selected digital master station models shall provide: subscriber directory with direct access, pre-programmable function menus, selectable language, and adjustable display contrast.

C. Substations

1. General

a. Each Intercom substation shall be equipped with microphone, loudspeaker and in-use LED, all housed in one unit with configurable front pushbutton(s).

b. Additional features on selected models shall include:

(1) Duplex-controller

(2) Volume control and microphone sensitivity adjustment

(3) On board relay contacts and inputs

(4) connectivity for up to 3 pre-programmable function/dialing pushbuttons and

(5) Speech control buttons "T" and "X"

(6) Onboard amplifier for external loudspeaker

c. Substations may be available as: desktop (with or without display), wall mount (flush or recessed), single gang or double gang with no adapters required.

d. All double gang substations shall be weather resistant, equipped with stainless steel faceplate and tamperproof pushbuttons. Selected tamperproof models shall have a second protective plate between faceplate and speaker/microphone.

e. Refere to the drawings for additional station information.

2. IP Substations:

a. It shall be possible to connect any Commend master station (digital or analog), with the use of the Commend intercom IP station adapter, directly to a network

static IP address, with no limit or compromise to station audio quality or function.

b. In addition, due to the DSP functionality of the IP Adapter, all analog stations connected via IP Adapter shall have all DSP functions normally associated with Digital/DSP stations. These functions include:

(1) Full Open Duplex communication, with or without gooseneck microphone or handset
(2) Integral audio threshold monitoring (D level firmware)
(3) Speaker and microphone monitoring (D level firmware).

c. As an option, a two input / output plug in board shall be available in addition to the contact closures and inputs found on various models of intercom station.

d. Firmware/feature upgrades shall be made available via download through the intercom server over the IP network. No local modification on the station shall be required.

e. IP Substation – As an alternative to using an IP Adapter plus a digital or analog substation, it shall be possible to utilize an IP ready 3 gang Tamper/Weather Resistant Security Substation. This substation shall include 2 inputs and 2 outputs and is power over Ethernet (POE) ready. This IP substation shall mount in an industry standard 3 gang deep back box (provided by others).

3. Camera Substations:

a. Select intercom substations shall be equipped with camera.
b. The camera station shall come in weather proof tamper resistant or interior plastic wall surface or flush mountable versions.
c. The camera shall be IP or analog video capable.
d. Camera shall be configurable to the following; 320x240 or 640x480 resolution, video format JPEG (MJPEG) picture rate up to 30 frames per second.
e. Supported protocols HTTP, ARP, UDP, TCP, ICMP, DHCP, Ethernet 10/100 MBit/s half-/full duplex, standard http-URL for display/integration to 3rd party.
f. Camera shall have LED-white light illumination with automatic “dawn to dusk” ambient light sensor and thermostat controlled internal heater.
g. Network Requirements.

(1) Intercom bandwidth requirement 146 Kb/s per active conversation.
(2) Network latency 100ms (Max) 10/100 Full duplex.
(3) Camera bandwidth requirements 350 Kb/s per active video stream based on 320x240 resolution @ 15 FPS.

4. Station ICM-1 shall be a master station with TFT monitor consisting of the following:

a. Commend WS810PI POE station
b. Commend WSSH50P surface kit
c. Commend WSDK50P desk kit

5. Station ICM-2 shall be vandal resistant wall station with one (1) call button

a. Commend WS201VI POE station
b. Commend WSSH50VSS stainless steel surface-mount kit

6. Station ICM-3 shall be vandal resistant with color camera and one (1) button call

a. Commend WS201VICM
b. Commend WSSH50VSS stainless steel surface-mount kit

2.4 CUSTOM STATIONS

A. The manufacturer of the Intercom system shall also provide flexible intercom kits to support specific customer applications (shape of housings, buttons, mounting material can be individually adapted for all situations where an intercom station is permanently mounted).

1. To cover different configurations digital (2-wire) and IP modules shall be available.
2. The digital and IP station modules shall employ DSP-technology (selected models), full microphone and speaker supervision shall be provided at each DSP-equipped station and accommodate up to 18-button keypad and up to 2 programmable Inputs/ Outputs. Failure of microphone and/or speaker shall be reported to a designated master station(s).
3. Full Open Duplex shall be available between DSP station module and DSP master stations.
4. Analog station modules shall be upgradable to DSP features via DSP license feature upgrade to the subscriber card in the intercom server.
5. Selected models shall support single-line alphanumeric display or graphic LCD.
6. All speakers / microphones shall be weatherproof.
7. Selected models shall have Duplex-controller on board.
8. Weatherproof modules shall be available

2.5 COMWIN/COMVID/COMREPORTER WORKSTATION SOFTWARE:

A. Selected intercom master stations shall have the ability to work in conjunction with a customizable graphical user interface (GUI) mapping program to enable an intuitive operation of the intercom system. The customizable GUI shall have the following functionality:

1. Ability to network together up to 50 clients (workstations) in one system
2. Communication with intercom stations and activation of associated relays can be initiated and terminated by selecting customized icons on the mapping screen.
3. The GUI shall have an unlimited number of maps and icons
4. Operation of the GUI program shall be license driven, and not require a software dongle.
5. Connectivity between the Comwin server PC and intercom server shall be serial or IP. Client workstations shall be networked to the Comwin server.
6. The GUI mapping program shall have the ability to operate independently from or as one system with the following software package and license:
7. Reporting Software
8. Video Management Software
9. Maintenance Software

PART 3 - EXECUTION

3.1 QUALITY CONTROL

A. All components of the public address system as a whole shall meet or exceed the minimum standards issued by the EIA. All work in conjunction with this installation shall meet the requirements of the National Electrical Code.

B. The Contractor shall provide necessary transient protection of the AC power feeding the intercom system. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

3.2 INSTALLATION, WIRING AND RACEWAY

A. Preparatory work required to accommodate the intercom system installation, i.e., conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required, shall be furnished and installed by the Contractor.

B. The intercom system supplier shall provide expert supervision of the installation and in addition, shall furnish the necessary wiring diagrams and instructions required to make the final system installation complete.

C. The installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

D. The Contractor shall make installation in strict accordance with approved manufacturer's drawings and instructions.

E. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Architect/Engineer.

F. All equipment power wiring and grounding shall conform to the National Electrical Code and applicable local codes.

G. All electronic equipment shall be grounded.

H. All cable shall be adequately supported and connectors specifically designed for the type cable in use.

3.3 WIRING

A. The Contractor shall furnish and install all wiring, conduit, back-boxes, pull boxes, outlets and boxes for the erection and operation of a complete intercom system as specified and described in these specifications, as shown on the drawings and recommended by the manufacturer.

B. All equipment power wiring shall be of the same type for lighting and power. Wiring shall meet the requirements of the National, State and local electrical codes.

C. All intercom system cabling shall be run in conduit.

D. Station Cable – Category 6 (color shall be different that that used in other communications sections) or as specified by the manufacturer.

E. Final connections between equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer of the equipment furnished. At the completion of the installation the manufacturer's representative shall test and adjust the system.

3.4 SYSTEM TEST AND ADJUSTMENTS

A. Before final acceptance of the intercom system, the manufacturer/supplier of system shall, in presence of Contractor and Owner, test each and every component and device in the system. The test shall be documented with signed copy submitted to the Contractor, Owner and Architect/Engineer.

B. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and level controls to insure proper system operation.

C. The system shall be physically inspected by the Owner's representative and the Architect/ Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.

D. As a minimum requirement, the intercom system should be tested to prove the following:

1. The complete system is free from grounds, opens and shorts.
2. Each device functions as specified herein.
3. Abnormal condition of any circuit or device which is to be electrically supervised shall be checked for trouble indication.

3.5 OWNER INSTRUCTION ON SYSTEMS OPERATION

A. Upon completion of the work, and prior to acceptance of the same by the Owner, the Contractor and the major equipment manufacturer's qualified representative shall spend time with the facility personnel, instructing them on the operation and service of all the public address system equipment and controls.

B. The Contractor shall properly instruct maintenance personnel to perform emergency repairs to the system such as replacement of defective standard components such as stations, etc.

END OF SECTION

DIVISION 28
ELECTRONIC SAFETY

SECTION 28 1300

ACCESS CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor shall be held to have read all the Bidding Requirements; all of the General Conditions and Supplementary General Conditions and all Divisions of the Technical Specifications before submitting a bid proposal for the project, and in the execution of the work, they will be bound by all of the conditions and requirements therein.

1.2 WORK INCLUDED

A. Work in this section includes, but is not limited to the following items:

1. Access Control Equipment.
2. Server.
3. Software.
4. Programming.

B. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in Contract Documents.

1.3 COORDINATION

A. Coordinate all work indicated in this section with all work included and specified elsewhere in the project. This includes, but is not limited to the Specification Sections in Div. 1 and Div. 26.

B. Coordinate all work to be performed with actual field and project conditions. At a minimum, Contractor is to perform the following tasks prior to submitting bids or shop drawings for the project:

1. Perform field investigations to determine all necessary incidental items which will be required for complete and proper installation of all work. Verify all items affecting the bid price prior to bidding.
2. Perform all necessary field measurements to provide complete, accurate, and coordinated shop drawing submittals
3. Organize and attend all necessary coordination meetings required to assure proper coordination and installation of all related work included in the project.

1.4 SUBMITTALS

A. Submit the manufacturers catalog Product Data Sheets for each and every product specified in this section.

B. Provide Shop Drawings for special assemblies and construction details as required by the Engineer. This includes, but is not limited to the following items:

1. Reinforcing and bracing required to meet the design criteria specified herein.
2. Details of conditions unique to the project. This includes details indicated on the contract drawings, details to address specific job conditions, or details that the contractor may propose to use which differ from those indicated on the contract drawings.
3. Details required to achieve required Fire Ratings.

C. Underwriters Laboratory Certification for all products and assemblies to be used on the project.

1.5 QUALITY ASSURANCE

A. Qualifications: The Contractor is to have satisfactorily performed work of similar scope on projects of similar size for a minimum of 10 years.

B. Warranties: All work is to be subject to the following warranties:

1. Materials Warranties: The material manufacturers standard warranties are to be provided for each product unless otherwise indicated, but no less than one (1) year.
2. Labor and Workmanship Warranty: Provide a one (1) year warranty against defects in workmanship which lead to failures within that period. Contractor's warranty is to include the correction of all other related work affected by any failure. Contractor will at their own expense without charge to the City make repair to the originally specified condition of all work required to be corrected as a result of all failures occurring within the warranty period.

C. Regulatory Requirements: All work is to be completed in accordance with all the latest requirements of the following authorities and/or documents the most stringent requirements of which will apply:

1. Underwriters Laboratories, Inc. (U.L.) - "Fire Resistance Directory".

D. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Engineer. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

E. Installation shall be accordance with NFPA-70 (National Electric Code), National Electric Safety Code (NESC), state codes, local codes, and requirements of City having jurisdiction.

F. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA and IEEE Standards.

G. Each item shall bear the UL Label.

H. The system provider must:

1. AMAG Technologies is the current access control provider for the City of Lynchburg.
2. Provide equipment from manufacturers for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing the City that the provider has authority to sell and service the equipment in this territory.
3. Demonstrate that they have successfully installed these systems, utilizing their standard products, for a period of five (5) years.
4. Maintain a service organization to provide both normal and emergency service. Emergency service must be available 24 hours per day, 365 days per year and staff must be adequate to respond within 2 hours of an emergency call.
5. Maintain adequate spare parts inventory to provide both normal and emergency service.
6. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.
7. Own and demonstrate proficiency in the use of the required test equipment, tools, etc. for the proper installation, set-up, testing and maintenance of the system. If requested, must provide a listing of tools and/or equipment and where appropriate, certifications in the proper training and use of the tools and/or equipment.

1.6 GENERAL DESCRIPTION

A. The work included in this section is shown on the drawings or described in the specifications, and consists of furnishing all labor, material, services, and skilled supervision necessary for the construction, erection, installation, and connection of all circuits, apparatus, and equipment specified herein or shown on the drawings in a first class, workmanlike manner, and its delivery to the City ready for use.

B. Each part of work is to be complete in detail and operable in unison with all other sections, to constitute completely installed access control system and connections of same, as shown on drawings and described in specifications.

C. Work in this section includes, but is not limited to:

1. Access Control for certain areas in the new maintenance facility with control and management of the system located at the City.
2. The Contractor shall do everything necessary to make a thoroughly satisfactory and working system, including furnishing and installing all items required to complete the work, whether specifically called for or not. The Contractor shall obtain all wiring requirements from the system manufacturer prior to bidding and include in his bid all wiring as recommended by the manufacturer.
3. The system specified is based on AMAG Technologies equipment compatible with other systems used by the City.
4. The access control system shall consist of all necessary equipment to perform the following functions:

   a. Allow/prevent access to certain areas of the facility.
   b. Communicate over the City’s network.

5. System shall be fully programmed.
6. Provide equipment and wiring.

1.7 INSTALLATION

A. The ACS shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel.

B. All materials supplied by the Contractor shall be new and shall comply with the latest published specifications and recommendations of the manufacturer in all respects unless otherwise indicated. The Contractor shall supply the latest model available for all equipment items. Unless otherwise indicated in the specification, all electronic equipment shall be a standard, unmodified production model.

C. Equivalent products may not be substituted for previously approved products unless the Engineer has approved a written request from the Contractor. All requests for substitute equipment must reflect a complete description of the proposed substitute equipment, including manufacturer's technical descriptions, drawings and technical performance.

D. The Contractor shall be responsible for providing complete and operational subsystems, including but not limited to all hardware, software, wire, cable, conduit and boxes, power circuit connections, terminal blocks, labor, management, engineering, training, testing, relocation adjusting and connection to NIC work and devices.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Access Control System's (ACS) primary function shall be to regulate access through specific doors to secured areas of the facility.

B. All system features and functionality listed in the proceeding pages shall ship with each system. The Contractor shall work with the City to develop and configure the system.

2.2 TERMS AND ABBREVIATIONS

A. ACS Access Control System, incorporates the entire access control network, including the system controllers.

B. System controller. The hardware components of the system to which the physical components (input devices, entry devices, and output devices) of the access control system connect. The system controller communicates with the ASC computer.

C. NIC Network Interface Card.

D. DC Door Control Module

2.3 STANDARDS

A. The System controllers shall comply with at least two standards from the following compliance regulations:

1. CE
2. UL

B. The purpose of these regulations is to maximize the operational usability of the product and to ensure minimum standards within the access control system development have been maintained. These standards will also ensure electromagnetic interference between electronic products are minimized as these may diminish the performance of electrical products or disrupt essential communications.

2.4 SYSTEM ARCHITECTURE

A. The system shall be of a Controller / Client architecture

B. Dial-in capability from remote workstation to the system using a remote access service shall also be available.

C. Encryption between the controller and each Client is configurable and safeguarded using IPSec, to ensure the integrity and security of the data transferred.

2.5 INTELLIGENT SYSTEM CONTROLLERS

A. The system shall be configured with the ACS software connected via an Ethernet link to any configurable number of system controllers.

B. The system shall employ a distributed architecture so that all access decisions are made locally at the system controller. All decisions to grant access shall be made by the local system controller.

C. A System controller shall link the ACS software to all other field hardware. It shall provide full distributed processing for access control and alarm monitoring operations. Access levels, hardware configurations and programmed alarm outputs assigned at the administrative workstation shall be downloaded to the ACS software. All access granted/denied decisions shall be made at the system controller to provide fast responses to card reader transactions.

D. The system controller shall be required to operate in a stand-alone and peer-to-peer mode in the event it loses communication with system software. It shall continue to make access granted/denied decisions and maintain a log of events. Events shall be stored in local memory, and then uploaded automatically to the system when communications are restored. Furthermore, an individual system controller shall be able to communicate with another system controller to distribute cardholder locations, and to perform scheduled and alarm events.

E. The System Controllers shall be Symmetry Multinode M2150 or equal. Provide the quantity required including the door control modules to control the doors shown on the drawings.

F. Ethernet Communications

1. The system controller shall communicate with any standard WAN / LAN communications link. The system controller shall provide an integrated onboard port for direct Ethernet connection.

2. Provide Ethernet interface devices as required.

G. Backup battery

1. The system controller will have an internal battery backup to ensure standby operation to be achieved and allow fail-over to provide continuous operation, even during intervals when the main power is lost. Upon Power Failure, the system controller will immediately report power failure to the ACS host and this event will be logged to the ACS audit trail. In addition, the system controller shall report warnings to the ACS when battery power is low.

H. Power Supply (s)

1. Provide the required number of power supplies for the number of doors being controlled.

2.6 CARD READERS AND CARDS

A. The system shall be compatible with Javelin S870 prox cards currently being used by the City.

B. Provide proximity card readers and keypads where shown on the drawings.

2.7 HOST EVENT PROCESSING

A. Immediate propagation

1. The ACS shall be capable of processing events in the system as they occur, and distributing this information throughout the entire access control network using the Hub Manager Professional Software.
2. Changes made using the ACS software shall be automatically recorded and downloaded to the correct system controller. In addition, the ACS software shall also provide the tools to manually download all appropriate database information, allowing the full initialization of each system controller.
3. All database changes shall be performed while the workstation is on-line without disrupting other system operations.
4. Changes made at the system controller equipment shall be automatically uploaded to the ACS host, to ensure system continuity. Each system controller shall be capable of reporting all changes in status, system events, and actions performed, to the ACS in real-time. These messages shall be displayed immediately in the ACS audit trail. The affect of each message must be reflected throughout the system as they occur, such as, the immediate changing of the color of a symbol located on a site plan to indicate a change in point status.

B. Local event buffer

1. The system controller shall maintain a buffer of all events that occur locally. This buffer shall store all messages until they are uploaded to the ACS host. If the communications between the system controller and the ACS are lost, the buffer will be retained until communications is restored, at which point all logged events shall be uploaded to the ACS.

2.8 SCHEDULING

A. The system must provide the capability for an operator to define specific times, during which certain events and system control will occur. These schedules must be operator customisable, so that, they can schedule events across an entire week, with up to twenty distinct time periods during that week. Primarily, the time schedules must be able to handle holidays, provide access at certain times, and schedule or permit events during the specified times.

B. Holidays

1. The system must be capable of defining over 100 holidays in advance of them occurring. A defined holiday will override the normal timed schedules where configured and allow other system functions to behave as normal.

C. Access per door

1. The system must be capable of scheduling specific times when a cardholder is permitted to access a specified door, barrier or gate. At all other times the cardholder will be prevented from gaining access at that door.

D. By specific date & time

1. The system shall be capable of scheduling certain programmable events to occur on specific dates or during specific times of the day.

E. By certain event

1. The system shall be capable of scheduling certain programmable events to occur in response to the activation of another events or system status change. The events or status changes that trigger this response shall be fully configurable.

PART 3 - EXECUTION

3.1 QUALITY CONTROL

A. All components of the access control system as a whole shall meet or exceed the minimum standards. All work in conjunction with this installation shall meet the requirements of the 2005 National Electrical Code.

B. The system shall be listed by Underwriter's Laboratories, Inc., and each of the major components shall bear the manufacturer's name, catalog number and U.L. label.

C. The Contractor shall provide necessary transient protection of the AC power feeding the access control system. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

3.2 INSTALLATION, WIRING AND RACEWAY

A. Preparatory work required to accommodate the access control/intrusion detection system system installation, i.e., conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required, shall be furnished and installed by the Contractor.

B. The system supplier shall provide expert supervision of the installation and in addition, shall furnish the necessary wiring diagrams and instructions required to make the final system installation complete.

C. The installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

D. The Contractor shall make installation in strict accordance with approved manufacturer's drawings and instructions.

E. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Engineer.

F. All equipment power wiring and grounding shall conform to the National Electrical Code and applicable local codes.

G. All electronic equipment shall be grounded.

H. All cable shall be adequately supported and connectors specifically designed for the type cable in use.

3.3 DOCUMENTATION

A. Software Documentation

1. The ACS manufacturer shall be able to supply a full range of software documentation. Including:

   a. An lnstallation Guide
   b. A User's Guides for the core software module and any additional optional modules
   c. Product Sheets that outline the system requirements and specifications

B. Hardware Documentation

1. The ACS manufacturer shall be able to supply a full range of system controller documentation. Including:
2. User's Guides
3. Installation Sheets
4. Product Sheets that outline the system requirements and specifications.

3.4 WIRING

A. The Contractor shall furnish and install all wiring, conduit, back boxes, pull boxes, outlets and boxes for the erection and operation of a complete system as specified and described in these specifications, as shown on the drawings and recommended by the manufacturer.

B. All equipment power wiring shall be of the same type for lighting and power. Wiring shall meet the requirements of the National, State and local electrical codes.

C. All cabling shall be as directed by the manufacturer.

D. Final connections between equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer of the equipment furnished. At the completion of the installation the manufacturer's representative shall test and adjust the system.

3.5 SYSTEM TEST AND ADJUSTMENTS

A. Before final acceptance of the access control system, the manufacturer/supplier of system shall, in presence of Contractor, the Engineer, test each and every component and device in the system. The test shall be documented with signed copy submitted to the Contractor and the Engineer.

B. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals, levels, calibration, etc. to insure proper system operation.

C. The system shall be physically inspected by the Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.

3.6 THE CITY INSTRUCTION ON SYSTEMS OPERATION

A. Upon completion of the work, and prior to acceptance of the same by the City, the Contractor and the major equipment manufacturer's qualified representative shall spend a minimum four (4) hours with the facility personnel, instructing them on the operation and service of all the system equipment and controls.

B. The Contractor shall properly instruct maintenance personnel to perform emergency repairs to the system such as replacement of defective standard components.

END OF SECTION

SECTION 28 1301

INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor shall be held to have read all the Bidding Requirements; all of the General Conditions and Supplementary General Conditions and all Divisions of the Technical Specifications before submitting a bid proposal for the project, and in the execution of the work, they will be bound by all of the conditions and requirements therein.

1.2 WORK INCLUDED

A. Work in this section includes, but is not limited to the following items:

1. Intrusion Detection Hardware.
2. Software.
3. Programming.

B. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in Contract Documents.

1.3 COORDINATION

A. Coordinate all work indicated in this section with all work included and specified elsewhere in the project. This includes, but is not limited to the Specification Sections in Div. 1 and Div. 26.

B. Coordinate all work to be performed with actual field and project conditions. At a minimum, Contractor is to perform the following tasks prior to submitting bids or shop drawings for the project:

1. Perform field investigations to determine all necessary incidental items which will be required for complete and proper installation of all work. Verify all items affecting the bid price prior to bidding.
2. Perform all necessary field measurements to provide complete, accurate, and coordinated shop drawing submittals
3. Organize and attend all necessary coordination meetings required to assure proper coordination and installation of all related work included in the project.

1.4 SUBMITTALS

A. Submit the manufacturers catalog Product Data Sheets for each and every product specified in this section.

B. Provide Shop Drawings for special assemblies and construction details as required by the Engineer. This includes, but is not limited to the following items:

1. Reinforcing and bracing required to meet the design criteria specified herein.
2. Details of conditions unique to the project. This includes details indicated on the contract drawings, details to address specific job conditions, or details that the contractor may propose to use which differ from those indicated on the contract drawings.
3. Details required to achieve required Fire Ratings.

C. Underwriters Laboratory Certification for all products and assemblies to be used on the project.

1.5 QUALITY ASSURANCE

A. Qualifications: The Contractor is to have satisfactorily performed work of similar scope on projects of similar size for a minimum of 10 years.

B. Warranties: All work is to be subject to the following warranties:

1. Materials Warranties: The material manufacturers standard warranties are to be provided for each product unless otherwise indicated, but no less than one (1) year.
2. Labor and Workmanship Warranty: Provide a one (1) year warranty against defects in workmanship which lead to failures within that period. Contractor's warranty is to include the correction of all other related work affected by any failure. Contractor will at their own expense without charge to the City make repair to the originally specified condition of all work required to be corrected as a result of all failures occurring within the warranty period.

C. Regulatory Requirements: All work is to be completed in accordance with all the latest requirements of the following authorities and/or documents the most stringent requirements of which will apply:

1. Underwriters Laboratories, Inc. (U.L.) - "Fire Resistance Directory".

D. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Engineer. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

E. Installation shall be accordance with NFPA-70 (National Electric Code), National Electric Safety Code (NESC), state codes, local codes, and requirements of City having jurisdiction.

F. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA and IEEE Standards.

G. Each item shall bear the UL Label.

H. The system provider must:

1. Provide equipment from manufacturers for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing the City that the system provider is authorized to sell and service the equipment in this territory.
2. Demonstrate that they have successfully installed these systems, utilizing their standard products, for a period of five (5) years.
3. Maintain a service organization to provide both normal and emergency service. Emergency service must be available 24 hours per day, 365 days per year and staff must be adequate to respond within 2 hours of an emergency call.
4. Maintain adequate spare parts inventory to provide both normal and emergency service.
5. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.
6. Own and demonstrate proficiency in the use of the required test equipment, tools, etc. for the proper installation, set-up, testing and maintenance of the system. If requested, must provide a listing of tools and/or equipment and where appropriate, certifications in the proper training and use of the tools and/or equipment.
7. The system provider currently providing services to the City is AMAG Technologies.

1.6 GENERAL DESCRIPTION

A. The work included in this section is shown on the drawings or described in the specifications, and consists of furnishing all labor, material, services, and skilled supervision necessary for the construction, erection, installation, and connection of all circuits, apparatus, and equipment specified herein or shown on the drawings in a first class, workmanlike manner, and its delivery to the City ready for use.

B. Each part of work is to be complete in detail and operable in unison with all other sections, to constitute completely installed intrusion detection system and connections of same, as shown on drawings and described in specifications.

C. Work in this section includes, but is not limited to:

1. Intrusion detection for certain areas in the new maintenance facility with control and management of the system.
2. The Contractor shall do everything necessary to make a thoroughly satisfactory and working system, including furnishing and installing all items required to complete the work, whether specifically called for or not. The Contractor shall obtain all wiring requirements from the system manufacturer prior to bidding and include in his bid all wiring as recommended by the manufacturer.
3. The system specified is based on equipment standardized on by the City.
4. The intrusion detection system shall consist of all necessary equipment to perform the following functions:
   a. Alarm unauthorized entrance into the facility.
   b. Communicate alarms over the City’s network back to the Monitoring Station.
5. Provide equipment and wiring.

1.7 INSTALLATION

A. The system shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel.

B. All materials supplied by the Security Contractor shall be new and shall comply with the latest published specifications and recommendations of the manufacturer in all respects unless otherwise indicated. The Security Contractor shall supply the latest model available for all equipment items. Unless otherwise indicated in the specification, all electronic equipment shall be a standard, unmodified production model.

C. Equivalent products may not be substituted for previously approved products unless the Engineer has approved a written request from the Security Contractor. All requests for substitute equipment must reflect a complete description of the proposed substitute equipment, including manufacturer's technical descriptions, drawings and technical performance.

D. The Security Contractor shall be responsible for providing complete and operational subsystems, including but not limited to all hardware, software, wire, cable, conduit and boxes, power circuit connections, terminal blocks, labor, management, engineering, training, testing, relocation adjusting and connection to NIC work and devices.

PART 2 - PRODUCTS

2.1 GENERAL

A. The intrusion detection system's primary function shall be to alarm unauthorized entry to the facility.

B. All system features and functionality listed in the proceeding pages shall ship with each system. Features and functionality available to the City. The Security Contractor shall work with the City to develop and configure the system.

2.2 STANDARDS

A. The System controllers shall comply with at least two standards from the following compliance regulations:

1. CE
2. UL

B. The purpose of these regulations is to maximize the operational usability of the product and to ensure minimum standards within the access control system development have been maintained. These standards will also ensure electromagnetic interference between electronic products are minimized as these may diminish the performance of electrical products or disrupt essential communications.

2.3 ALARM CONTROLLER

A. The system shall be configured with software connected via hard wire.

B. An alarm controller shall link the software to all other field hardware. It shall provide full distributed processing for alarm monitoring operations. Hardware configurations and programmed alarm outputs assigned at the administrative workstation shall be downloaded to the software.

C. The alarm controller shall be required to operate in a stand-alone mode in the event it loses communication with system software. It shall continue to make maintain a log of events. Events shall be stored in local memory, and then uploaded automatically to the system when communications are restored. Furthermore, an individual alarm controller shall be able to perform alarm events.

D. Backup battery

1. The alarm controller will have an internal battery backup to ensure standby operation to be achieved and allow fail-over to provide continuous operation, even during intervals when the main power is lost. Upon Power Failure, the controller will immediately report power failure to the host and this event will be logged to the audit trail. In addition, the alarm controller shall report warnings when battery power is low.

E. Input and Output control

1. A hardware module shall monitor independent input devices and reports line fault conditions, alarm conditions, and power failure. When an alarm input is activated, the condition shall be reported to the host workstation. The same module shall also allow the control of up to 16 output devices, which can be controlled via the change in state of an input (monitor point) or a command received.

F. Housings equipment tamper switches

1. All alarm components shall be housed in a lockable metal cabinet that is fitted with equipment tamper switches and meets the appropriate environmental requirements. The controller shall allow the connection of equipment tamper switches to detect access to security equipment and shall consist of a spring loaded switch assembly. Any movement of the cabinet door shall cause the switch contacts to transfer. Tamper switches shall incorporate SPDT contacts and be mounted within each cabinet containing security equipment such that the switch cannot be disabled from the cabinet exterior.

G. Controller shall be Honeywell/First Alert FA168 or extension of the AMAG Technologies system at the Transfer Station.

2.4 COMMUNICATIONS

A. The system shall employ proprietary communications protocols. The encryption between the host and alarm controller shall encrypt all messages and ensure data security.

B. The connection between the Host and the alarm controller shall use a proprietary protocol.

C. Contractor to provide an RJ31X termination block and coordinate with the telephone vendor the interconnection to allow the alarm system to take control of a phone line in the event of an alarm.

2.5 ALARM MANAGEMENT

A. This system shall allow the visual and audible annunciation of alarm events as they occur, in real-time. The annunciation of an alarm shall take priority over all other system functionality to ensure the alarm is registered immediately upon occurring. All alarm management shall be from the Dillard Alarm Company central station.

B. Alarm annunciation central monitoring station

1. The system shall provide an audible and visual annunciation of all appropriate alarm situations as they occur. Each alarm annunciation shall be configurable, so that it requires positive action to be taken by the System Operator when acknowledging it.
2. Immediately following the visual and audible annunciation of an alarm, a field shall become available where the system operator can enter comments regarding the alarm situation, and shall prevent the alarm from being cleared until an entry in this field has been made. Once entered the System Operator shall be allowed to acknowledge the alarm.
3. In addition, pre-defined alarm responses shall be available. These responses are specific to the facility and can be selected from a drop-down list to ensure quick and efficient acknowledgement of an alarm situation, in lieu of typing a message.
4. After an alarm has been announced, the system shall allow the operator to silence the alarm for a selected period of time. After this time period has elapsed the alarm annunciation will be regenerated.
5. Upon an alarm being announced, the System Operator shall be provided with the facility to view an alarm queue before taking further action. Alarms with the highest priority shall be placed at the head of the queue. As a minimum the alarm queue will display the following alarm attributes:

    a. Priority of the alarm
    b. Date and time at which the alarm occurred
    c. Name of the system component that caused or initiated the alarm
    d. Current status of the system component that caused or initiated the alarm

6. The system shall provide the unique emergency instructions to be specified for each type of alarm. These instructions should be displayed on request before the alarm is actioned, in order to help the Operator understand the requirements and necessary routines for clearing the alarm

2.6 ALARM INITIATION DEVICES

A. Door Switches

1. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
2. Flush-Mounted Switches: Unobtrusive and flush with surface of door frame.
3. Coordinate the type and installation of the switches with the door frame, door, and hardware vendors.

B. Microwave-Pir Dual-Technology Motion Sensors (Basic of Design)

1. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
2. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.

    a. Minimum Detection Pattern: A room 20 by 30 feet.
    b. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across 2 adjacent segments of detector's field of view.
    c. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps. Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
    d. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
    e. Detectors shall be Honeywell model DT 7435.

C. Keypads

1. Keypads shall be Honeywell Model 6061.

D. Sensors

1. Glass Break Audio and Shock Sensor shall be Honeywell Model 2500.

PART 3 - EXECUTION

3.1 QUALITY CONTROL

A. All components of the access control/intrusion detection system as a whole shall meet or exceed the minimum standards. All work in conjunction with this installation shall meet the requirements of the National Electrical Code.

B. The system shall be listed by Underwriter's Laboratories, Inc., and each of the major components shall bear the manufacturer's name, catalog number and U.L. label.

C. The Contractor shall provide necessary transient protection of the AC power and telephone line feeding the intrusion detection system. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

3.2 INSTALLATION, WIRING AND RACEWAY

A. Preparatory work required to accommodate the access control/intrusion detection system system installation, i.e., conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required, shall be furnished and installed by the Contractor.

B. The system supplier shall provide expert supervision of the installation and in addition, shall furnish the necessary wiring diagrams and instructions required to make the final system installation complete.

C. The installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

D. The Contractor shall make installation in strict accordance with approved manufacturer's drawings and instructions.

E. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Engineer.

F. All equipment power wiring and grounding shall conform to the National Electrical Code and applicable local codes.

G. All electronic equipment shall be grounded to the building grounding system.

H. All cable shall be adequately supported and connectors specifically designed for the type cable in use.

3.3 DOCUMENTATION

A. Software Documentation

1. The manufacturer shall be able to supply a full range of software documentation. Including:

   a. An lnstallation Guide
   b. A User's Guides for the core software module and any additional optional modules
   c. Product Sheets that outline the system requirements and specifications

B. Hardware Documentation

1. The manufacturer shall be able to supply a full range of system controller documentation. Including:
2. User's Guides
3. Installation Sheets
4. Product Sheets that outline the system requirements and specifications.

3.4 WIRING

A. The Contractor shall furnish and install all wiring, conduit, back boxes, pull boxes, outlets and boxes for the erection and operation of a complete system as specified and described in these specifications, as shown on the drawings and recommended by the manufacturer.

B. All equipment power wiring shall be of the same type for lighting and power. Wiring shall meet the requirements of the National, State and local electrical codes.

C. All cabling shall be as directed by the manufacturer.

D. Final connections between equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer of the equipment furnished. At the completion of the installation the manufacturer's representative shall test and adjust the system.

3.5 SYSTEM TEST AND ADJUSTMENTS

A. Before final acceptance of the intrusion detection system, the manufacturer/supplier of system shall, in presence of Contractor, the Engineer, test each and every component and device in the system. The test shall be documented with signed copy submitted to the Contractor and the Engineer.

B. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals, levels, calibration, etc. to insure proper system operation.

C. The system shall be physically inspected by the Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.

3.6 THE CITY INSTRUCTION ON SYSTEMS OPERATION

A. Upon completion of the work, and prior to acceptance of the same by the City, the Contractor and the major equipment manufacturer's qualified representative shall spend a minimum two (2) hours with the facility personnel, instructing them on the operation and service of all the video wall system equipment and controls.

END OF SECTION

SECTION 28 2300

CLOSE CIRCUIT TELEVISION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1, Division 26 and Division 27 Specification Sections, apply to this Section. The Contractor shall be held to have read all the Bidding Requirements; all of the General Conditions and Supplementary General Conditions and all Divisions of the Technical Specifications before submitting a bid proposal for the project, and in the execution of the work, they will be bound by all of the conditions and requirements therein.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Work in this section includes, but is not limited to the following items:

1. Cameras.
2. Monitors.
3. Computers
4. Network Video Recorder.
5. Power supplies
6. Switches
7. Miscellaneous

B. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in Contract Documents.

1.3 COORDINATION

A. Coordinate all work indicated in this section with all work included and specified elsewhere in the project. This includes, but is not limited to the Specification Sections in Div. 1, Div. 26 and Div 27.

B. Coordinate all work to be performed with actual field and project conditions. At a minimum, Contractor is to perform the following tasks prior to submitting bids or shop drawings for the project:

1. Perform complete review of the documents, manufacturer's recommendations and good design practices to determine all necessary incidental items which will be required for complete and proper installation of all work. Verify all items affecting the bid price prior to bidding.

2. Organize and attend all necessary coordination meetings required to assure proper coordination and installation of all related work included in the project.

1.4 SUBMITTALS

A. Submit the manufacturers catalog Product Data Sheets for each and every product specified in this section.

B. Provide Shop Drawings for special assemblies and construction details as required by the Engineer. This includes, but is not limited to the following items:

1. Reinforcing and bracing required to meet the design criteria specified herein.
2. Details of conditions unique to the project. This includes details indicated on the contract drawings, details to address specific job conditions, or details that the contractor may propose to use which differ from those indicated on the contract drawings.
3. Details required to achieving required Fire Ratings.

C. Underwriters Laboratory Certification for all products and assemblies to be used on the project.

1.5 QUALITY ASSURANCE

A. Qualifications: The Contractor is to have satisfactorily performed work of similar scope on projects of similar size for a minimum of 5 years.

B. Warranties: All work is to be subject to the following warranties:

1. Materials Warranties: The material manufacturers standard warranties are to be provided for each product unless otherwise indicated, but no less than one (1) year.
2. Labor and Workmanship Warranty: Provide a one (1) year warranty against defects in workmanship which lead to failures within that period. Contractor's warranty is to include the correction of all other related work affected by any failure. Contractor will, at their own expense without charge to the City, make repair to the originally specified condition of all work required to be corrected as a result of all failures occurring within the warranty period.

C. Regulatory Requirements: All work is to be completed in accordance with all the latest requirements of the following authorities and/or documents the most stringent requirements of which will apply:

1. Underwriters Laboratories, Inc. (U.L.)

D. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Engineer. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

E. Installation shall be accordance with NFPA-70 (National Electric Code), National Electric Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.

F. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA and IEEE Standards.

G. The system provider must:

1. Provide equipment from manufacturers for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing authority to sell and service the equipment in this territory.
2. Demonstrate that they have successfully installed these systems, utilizing their standard products, for a period of five (5) years.
3. Maintain a service organization to provide both normal and emergency service. Emergency service must be available 24 hours per day, 365 days per year and staff must be adequate to respond within 2 hours of an emergency call.
4. Maintain adequate spare parts inventory to provide both normal and emergency service.
5. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.
6. Own and demonstrate proficiency in the use of the required test equipment, tools, etc. for the proper installation, set-up, testing and maintenance of the system. If requested, must provide a listing of tools and/or equipment and where appropriate, certifications in the proper training and use of the tools and/or equipment.

1.6 GENERAL DESCRIPTION

A. The work included in this section is shown on the drawings or described in the specifications, and consists of furnishing all labor, material, services, and skilled supervision necessary for the construction, erection, installation, and connection of all circuits, apparatus, and equipment specified herein or shown on the drawings in a first class, workmanlike manner, and its delivery to the City ready for use.

B. Each part of work is to be complete in detail and operable in unison with all other sections, to constitute completely installed CCTV system and connections of same, as shown on drawings and described in specifications.

C. Work in this section includes, but is not limited to:

1. The CCTV system shall be monitored out of the Operations and remotely by the City.
2. The Contractor shall do everything necessary to make a thoroughly satisfactory and working system, including furnishing and installing all items required to complete the work, whether specifically called for or not. The Contractor shall obtain all wiring requirements from the system manufacturer prior to bidding and include in his bid all wiring as recommended by the manufacturer.
3. The CCTV system specified is based on equipment manufactured by Pelco. All reference to model numbers and other pertinent information is intended to establish the standards of performance, quality and appearance that must be met. The CCTV system shall consist of all necessary equipment to perform the following functions:

   a. Provide video images in and around the Maintenance Facility.
   b. Provide monitoring of images in the Operations area and remotely.

4. System shall be provided as shown on the drawings.
5. Provide equipment and wiring.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All systems and components shall be provided with the availability of a toll-free, 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.

D. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non-warranty items.

E. The CCTV system shall be by Pelco or equal.

2.2 INDOOR CCTV CAMERA DOME SYSTEM (Type A)

A. General

1. The network camera shall offer dual video streams with up to 1.2 MPx resolution (1280 x 960) in progressive scan format.
2. An alarm input and relay output shall be built in for integration with hard wired external sensors.
3. The network camera shall be vandal and tamper resistant.
4. The network camera shall be capable of firmware upgrades through a network using a software-based device utility.
5. The network camera shall provide an accessory port for hardware expansion and two-way audio.
6. The network camera shall offer auto back focus (ABF) functionality through a push button on the camera. ABF parameters shall also be configurable through a standard Web browser interface.
7. The network camera shall offer a video output port providing an NTSC/PAL analog video output signal for adjusting field of view and focus at the camera.
8. The network camera shall provide advanced low-light capabilities for day/night with sensitivity down to 0.10 lux in color and 0.05 lux in black-white.
9. The network camera shall have a removable IR cut filter mechanism for increased sensitivity in low-light installations. IR cut filter removal shall be configurable through a Web browser.
10. The network camera shall support two simultaneous, configurable video streams. H.264 and MJPEG compression formats shall be available for primary and secondary streams

with selectable unicast and multicast protocols. The streams shall be configurable in a variety of frame rates and bit rates.

11. The network camera shall support industry standard Power over Ethernet (PoE) IEEE 802.3af to supply power to the camera over the network.
12. The network camera shall use a standard Web browser interface for remote administration and configuration of camera parameters. The browser interface shall support multi-screen remote monitoring for up to 16 cameras on the same virtual local area network (VLAN).
13. The network camera shall have Camera Sabotage analytics to detect changes in the camera's field of view, including obstruction of the lens (examples include by cloth, spray paint, or a lens cap cover) and unauthorized movement of the camera. Such behaviors shall trigger an alarm.
14. The network camera shall have a window blanking feature to conceal user-defined privacy areas that cannot be viewed by an operator. The network camera shall support up to four blanked windows. A blanked area shall appear on the screen as a solid gray window.
15. The network camera shall support standard IT protocols.
16. The network camera shall support open architecture best practices with a published API available to third-party network video recording and management systems.
17. The network camera shall meet or exceed the following design and performance specifications.
18. Provide any required licenses.

B. Camera Specifications

1. Imaging Device: 1/3-inch, effective
2. Imager Type: CMOS
3. Imager Readout: Progressive scan
4. Maximum Resolution: 1280 x 960
5. Signal-to-Noise Ratio: 50 dB
6. Auto Iris Lens Type: DC drive
7. Electronic Shutter Range: 1~1/77,000 sec
8. Wide Dynamic Range: 120 dB
9. White Balance Range: 2,000° to 10,000°K
10. Sensitivity: f/1.2; 2,850°K; SNR >20dB
    a. Color (1x/33ms): 0.10 lux
    b. Color SENS (15x/500 ms): 0.005 lux
    c. Mono (1x/33ms): 0.05 lux
    d. Mono SENS (15x/500 ms): 0.0013 lux
11. Dome Attenuation
    a. Clear: Zero light loss
12. Construction
    a. Body: Cast aluminum
    b. Bubble: Polycarbonate plastic
13. Finish: Light gray powder coat
14. Weight: 1.4 lb (0.6 kg)
15. Available Languages: Chinese, English, French, German, Italian, Portuguese, Russian, Spanish, and Turkish

C. Video Specifications

1. Video Encoding: H.264 in base profile and MJPEG
2. Video Streams: Up to 2 simultaneous streams; the second stream variable is based on the setup of the primary stream
3. Frame Rate: Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6, 5, 4, 3, 2, and 1 (dependent upon coding, resolution, and stream configuration)
4. Available Resolutions
    a. 1.3 MPx: 1280 x 1024; 5:4 aspect ratio; 20.0 ips max., 10.0 Mbps bit rate for MJPEG; 8.0 ips max.,
    b. 1.2 MPx: 1280 x 960; 4:3 aspect ratio; 20.0 ips max., 9.8 Mbps bit rate for MJPEG; 8.0 ips max., 2.4 Mbps bit rate H.264
    c. 0.9 MPx: 1280 x 720; 16:9 aspect ratio; 30.0 ips max., 10.0 Mbps bit rate for MJPEG; 12.5 ips max., 2.5 Mbps bit rate H.264
    d. 0.5 MPx: 800 x 600; 4:3 aspect ratio; 30.0 ips max., 5.8 Mbps bit rate for MJPEG; 25.0 ips max., 2.0 Mbps bit rate H.264
    e. 0.3 MPx: 640 x 480; 4:3 aspect ratio; 30.0 ips max., 3.7 Mbps bit rate for MJPEG; 30.0 ips max., 1.6 Mbps bit rate H.264
    f. 0.1 MPx: 320 x 240; 4:3 aspect ratio; 30.0 ips max., 0.9 Mbps bit rate for MJPEG; 30.0 ips max., 0.4 Mbps bit rate H.264
5. Additional: 640 x 512, 640 x 352, 480 x 368, 480 x 272, 320 x 256, 320 x 176
6. Supported Protocols: TCP/IP, UDP/IP (Unicast, Multicast IGMP), UPnP, DNS, DHCP, RTP, RTSP, NTP, IPv4, SNMP v2c/v3, QoS, HTTP, HTTPS, LDAP (client), SSH, SSL, SMTP, FTP, MDNS (Bonjour®), and 802.1x (EAP)
7. Users
    a. Unicast: Up to 20 simultaneous users depending on resolution settings (2 guaranteed streams)
    b. Multicast: Unlimited H.264
8. Security Access: Password protected
9. Software Interface Web browser view and setup
10. Open IP Integration: Pelco IP camera API
11. Pelco System Integration: Endura® 2.0 (or later) or Digital Sentry® 4.3 (or later)
12. Minimum System Requirements for remote monitoring
    a. Processor: Intel® Pentium® 4 microprocessor 1.6 GHz
    b. Operating System: Microsoft® Windows® XP, Windows Vista®, or Mac® OS X 10.4 or later
    c. Memory: 512 MB
    d. Network Interface Card: 100 Mbps or greater
    e. Monitor: Minimum of 1024 x 768 resolution, 32-bit pixel color resolution
    f. Web Browser*: Internet Explorer® 7.0 or later, Mozilla® Firefox® 3.5 or later, Internet Explorer 8.0 or later is recommended for configuring analytics
    g. Media Player†: Pelco Media Player or QuickTime® 7.6.5 for Microsoft Windows XP, Windows Vista, or QuickTime 7.6.4 for Mac OS X 10.4

D. Electrical Specifications

1. Port: RJ-45 for 100Base-TX, Auto MDI/MDI-X
2. Cable Type: Cat5 cable or better for 100Base-TX
3. Power Input: PoE (IEEE802.3af Class 2)
4. Power Consumption: <3.9 W
5. Service Connector : External 3-connector, 2.5 mm provides NTSC/PAL video output

6. Accessory Port: Connects Pelco accessories
7. Audio: Bi-directional: half duplex line level/external microphone input, 600 ohm differential, Vp-p max signal level; Compression: G.711 PCM 64 kbit/s, built-in microphone.

E. Environmental Specifications

1. Operational Temperature: 32°F to 122°F (0°C to 50°C)
2. Operational Humidity: 20% to 80%, noncondensing
3. Impact Resistance: IK10++ per EN62262 (50J)

F. Mechanical Specification

1. Pan/Tilt Adjustment

a. Pan: 355°
b. Tilt: 180°
c. Rotate: 220°

G. Lens

1. 2.8-10 mm varifocal megapixel lens

H. Certifications

1. CE, Class A
2. FCC, Class A
3. UL/cUL Listed
4. C-Tick
5. KCC
6. Meets IP66 standards

I. Warranty

1. 3 years, parts and labor

J. Pelco Model Number

1. IM10LW10-1V: Sarix indoor fixed dome network camera, 1.2 MPx, day/night, 2.8-10 mm lens, clear dome

K. Accessories

1. IM-VE4S: 4S electrical box (deep) adapter plate

2.3 INDOOR/OUTDOOR (WET AREA) CCTV CAMERA DOME SYSTEM (Type B)

A. General

1. The network camera shall offer dual video streams with up to 3.1 MPx resolution (2048 x 1536) in progressive scan format.
2. An alarm input and relay output shall be built in for integration with hard wired external sensors.

3. The network camera shall provide a removable, local storage medium (Micro SD) for scheduled and event-based recording of images.
4. The network camera shall be outdoor/environmentally rated. The camera shall also be vandal and tamper resistant.
5. The network camera shall be capable of firmware upgrades through a network using a software-based device utility.
6. The network camera shall provide an accessory port for hardware expansion and two-way audio.
7. The network camera shall offer auto back focus (ABF) functionality through a push button on the camera. ABF parameters shall also be configurable through a standard Web browser interface.
8. The network camera shall offer a video output port providing an NTSC/PAL analog video output signal for adjusting field of view and focus at the camera.
9. The network camera shall provide advanced low-light capabilities for day/night with sensitivity down to 0.12 lux in color and 0.03 lux in black-white.
10. The network camera shall have a removable IR cut filter mechanism for increased sensitivity in low-light installations. IR cut filter removal shall be configurable through a Web browser.
11. The network camera shall support two simultaneous, configurable video streams. H.264 and MJPEG compression formats shall be available for primary and secondary streams with selectable unicast and multicast protocols. The streams shall be configurable in a variety of frame rates and bit rates.
12. The network camera shall support industry standard Power over Ethernet (PoE) IEEE 802.3af to supply power to the camera over the network. The network camera shall also offer a 24 VAC power input for optional use.
13. The network camera shall use a standard Web browser interface for remote administration and configuration of camera parameters. The browser interface shall support multiscreen remote monitoring for up to 16 cameras on the same virtual local area network (VLAN).
14. The network camera shall have Camera Sabotage analytics to detect changes in the camera's field of view, including obstruction of the lens (examples include by cloth, spray paint, or a lens cap cover) and unauthorized movement of the camera. Such behaviors shall trigger an alarm.
15. The network camera shall provide a built-in heater. The heater shall operate below 32°F (0°C) with 24 VAC power.
16. The network camera shall have a window blanking feature to conceal user-defined privacy areas that cannot be viewed by an operator. The network camera shall support up to four blanked windows. A blanked area shall appear on the screen as a solid gray window.
17. The network camera shall support standard IT protocols.
18. The network camera shall support open architecture best practices with a published API available to third-party network video recording and management systems.
19. The network camera shall meet or exceed the following design and performance specifications.

B. Camera Specifications

1. Imaging Device: 1/3-inch, effective
2. Imager Type: CMOS
3. Imager Readout: Progressive scan
4. Maximum Resolution: 2048 x 1536
5. Signal-to-Noise Ratio: 50 dB

6. Auto Iris Lens Type: DC drive
7. Electronic Shutter Range: 1~1/100,000 sec
8. Wide Dynamic Range: 60 dB
9. White Balance Range: 2,000° to 10,000°K
10. Sensitivity: f/1.2; 2,850°K; SNR >24dB
    a. Color (1x/33ms): 0.50 lux
    b. Color SENS (15x/500 ms): 0.12 lux
    c. Mono (1x/33ms): 0.25 lux
    d. Mono SENS (15x/500 ms): 0.03 lux
11. Dome Attenuation
    a. Clear: Zero light loss
12. Construction
    a. Body: Cast aluminum
    b. Bubble: Polycarbonate plastic
13. Finish: Light gray powder coat
14. Weight (without lens): 3.30 lb (1.50 kg)
15. Available Languages: Chinese, English, French, German, Italian, Portuguese, Russian, Spanish, and Turkish
16. Provide any required licenses.

C. Video Specifications

1. Video Encoding: H.264 in base profile and MJPEG
2. Video Streams: Up to 2 simultaneous streams; the second stream variable is based on the setup of the primary stream
3. Frame Rate: Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6, 5, 4, 3, 2, and 1 (dependent upon coding, resolution, and stream configuration)
4. Available Resolutions
    a. 3.1 MPx: 2048 x 1536; 4:3 aspect ratio; 12.0 ips max., 10.0 Mbps bit rate for MJPEG; 3.0 ips max., 2.6 Mbps bit rate H.264
    b. 2.1 MPx: 1920 x 1080; 16:9 aspect ratio: 15.0 ips max., 10.0 Mbps bit rate for MJPEG; 5.0 ips max., 2.7 Mbps bit rate H.264
    c. 1.9 MPx: 1600 x 1200; 4:3 aspect ratio; 15.0 ips max., 10.0 Mbps bit rate for MJPEG; 6.0 ips max., 2.6 Mbps bit rate H.264
    d. 1.3 MPx: 1280 x 1024; 5:4 aspect ratio; 20.0 ips max., 10.0 Mbps bit rate for MJPEG; 8.0 ips max.,
    e. 1.2 MPx: 1280 x 960; 4:3 aspect ratio; 20.0 ips max., 9.8 Mbps bit rate for MJPEG; 8.0 ips max., 2.4 Mbps bit rate H.264
    f. 0.9 MPx: 1280 x 720; 16:9 aspect ratio; 30.0 ips max., 10.0 Mbps bit rate for MJPEG; 12.5 ips max., 2.5 Mbps bit rate H.264
    g. 0.5 MPx: 800 x 600; 4:3 aspect ratio; 30.0 ips max., 5.8 Mbps bit rate for MJPEG; 25.0 ips max., 2.0 Mbps bit rate H.264
    h. 0.3 MPx: 640 x 480; 4:3 aspect ratio; 30.0 ips max., 3.7 Mbps bit rate for MJPEG; 30.0 ips max., 1.6 Mbps bit rate H.264
    i. 0.1 MPx: 320 x 240; 4:3 aspect ratio; 30.0 ips max., 0.9 Mbps bit rate for MJPEG; 30.0 ips max., 0.4 Mbps bit rate H.264
5. Additional: 640 x 512, 640 x 352, 480 x 368, 480 x 272, 320 x 256, 320 x 176

6. Supported Protocols: TCP/IP, UDP/IP (Unicast, Multicast IGMP), UPnP, DNS, DHCP, RTP, RTSP, NTP, IPv4, SNMP v2c/v3, QoS, HTTP, HTTPS, LDAP (client), SSH, SSL, SMTP, FTP, MDNS (Bonjour®), and 802.1x (EAP)
7. Users
    a. Unicast: Up to 20 simultaneous users depending on resolution settings (2 guaranteed streams)
    b. Multicast: Unlimited H.264
8. Security Access: Password protected
9. Software Interface: Web browser view and setup, up to 16 cameras
10. Open IP Integration: Pelco IP camera API
11. Pelco System Integration: Endura® 2.0 (or later) or Digital Sentry® 4.3 (or later)
12. Minimum System Requirements for remote monitoring
    a. Processor: Intel® Pentium® 4 microprocessor 1.6 GHz
    b. Operating System: Microsoft® Windows® XP, Windows Vista®, or Mac® OS X 10.4 or later
    c. Memory: 512 MB
    d. Network Interface Card: 100 Mbps or greater
    e. Monitor: Minimum of 1024 x 768 resolution, 32-bit pixel color resolution
    f. Web Browser*: Internet Explorer® 7.0 or later, Mozilla® Firefox® 3.5 or later, Internet Explorer 8.0 or later is recommended for configuring analytics
    g. Media Player†: Pelco Media Player or QuickTime® 7.6.5 for Microsoft Windows XP, Windows Vista, or QuickTime 7.6.4 for Mac OS X 10.4

D. Electrical Specifications

1. Port: RJ-45 for 100Base-TX, Auto MDI/MDI-X
2. Cable Type: Cat5 cable or better for 100Base-TX
3. Power Input: 18 to 30 VAC, 24 VAC nominal or PoE (IEEE802.3af Class 3)
4. Power Consumption: <7 W, <40 W with heater operation
5. Current Consumption
    a. PoE: <140 mA maximum
    b. 24 VAC: <510 mA nominal without heater operation, <2.5 A maximum with heater operation.
6. Local Storage: Micro SD
7. Alarm Input: 10 VDC maximum, 5 mA maximum
8. Alarm Output: 0 to 15 VDC maximum, 75 mA maximum
9. Service Connector: External 3-connector, 2.5 mm provides NTSC/PAL video output
10. Accessory Port: Connects Pelco accessories
11. Audio: Bi-directional: half duplex line level/external microphone input, 600 ohm differential, Vp-p max signal level; Compression: G.711 PCM 64 kbit/s.

E. Environmental Specifications

1. Operational Temperature: -22°F to 122°F (-30°C to 50°C); PoE operates between 32° to 122°F (0° to 50°C); 24 VAC power is required for heater operation below 32°F (0°C)
2. Thermostat Operation: Heater thermostatically controlled to operate below <41°F (<5°C)
3. Operational Humidity: 20% to 80%, noncondensing
4. Impact Resistance: IK10++ per EN62262 (70J)

F. Mechanical Specification

1. Pan/Tilt Adjustment

    a. Pan: 368°
    b. Tilt: 160° (10° to 170°)
    c. Rotate: 355°

G. Lens

1. 13M2.8-8: 2.8-8 mm varifocal megapixel lens, f/1.2-1.9

H. Certifications

1. CE, Class A
2. FCC, Class A
3. UL/cUL Listed
4. C-Tick
5. KCC
6. Meets IP66 standards

I. Warranty

1. 3 years, parts and labor

J. Pelco Model Numbers

1. IE30DN8-1: Sarix outdoor fixed dome network camera, 3.1 MPx, day/night, 2.8-8 mm varifocal megapixel lens, clear dome

K. Accessories

1. IM-VE4S: 4S electrical box (deep) adapter plate for flush mounting
2. IE-P: Pendent adapter
3. IE-S: Surface Adapter
4. SWM-SR: Wall Mount (also requires IE-P)

2.4 POWER SUPPLIES

A. General

1. Power supplies have been selected as appropriate for the specific camera installation.

B. Indoor Power Supplies

1. The power supply shall allow for powering 10 units from a single power source and shall allow for 24 VAC output for 1-10 units. The power supply shall allow the capability to handle, heater operation in addition to the camera.
2. The power supply has circuit breaker output
3. The power supply shall meet or exceed the following design and performance specifications.
4. Electrical Specifications

    a. Input Voltage: 120/240 VAC, 50/60 Hz
    b. Output Voltage: 4/26/28 VAC

c. Output Fuse/Circuit Breaker Ratings: 3 A
d. Input Connectors: Screw-type barrier strips
e. Output Connectors: Screw-type barrier strips; WCS4-20B is suitable for Class 2 wiring
f. Input Wire Size: 12-16 gauge solid wire
g. Output Wire Size: 16-22 gauge solid or stranded wire

5. Construction: Steel
6. Finish: Charcoal black polyester powder coat
7. Cable Entry: knockouts for 0.75-inch (1.9 cm) conduit
8. Certifications

a. CE
b. UL Listed
c. UL Listed to Canadian safety standards
d. Meets NEMA Type 4X and IP66 standards

9. Warranty

a. 1 year, parts and labor

10. Provide the following:

a. Two (2) MCS16-10B: Indoor multiple camera power supply, 120/240 VAC input. 10 circuit breaker 24/28 VAC outputs, total current capacity of 5 A (480 VA). One each located in each building

2.5 NETWORK VIDEO RECORDER

A. The network video recorder (NVR) shall provide a high-quality recording capable of storage and playback of images from 1 to 128 camera inputs. The NVR shall software for watermarking of each frame, inputs for external alarms, video motion detection, and scheduled event recording. Remote software shall be provided for operation via PC, web, and Pocket PC handheld devices.

1. Provide one (1) NVR.
2. Provide any required licenses

B. The IP video management system shall consist of Digital Sentry® NVs version 7 software operating on an optimized Pelco-supplied hardware platform. The NVs software shall consist of base software with individual, non-expiring licenses in the required quantity.

C. IP Video Management System

1. The IP video management system software updates shall be downloadable from a publicly available website.
2. The IP video management system shall support up to 128 combined IP and analog video streams, with up to 64 direct-attached analog cameras. Analog streams shall be supported using Pelco and/or third-party encoders.
3. The IP video management system shall provide 280 Mbps throughput for recording of analog and IP video streams, playback and export.
4. The IP video management system shall support recording of JPEG, MPEG-4 and H.264 IP streams.

5. The IP video management system shall support Pelco and third-party H.264 Megapixel video streams up to 10 Megapixel resolution with quantities based on a total system of 280 Mbps throughput for recording of analog and IP video streams, playback and export.
6. The IP video management system shall have a fully open architecture with support for both IP-specific camera as well as cameras with ONIVIF compliance.
7. The IP video management system shall support automatic detection of Pelco IP cameras. Third-party IP cameras shall be automatically detected dependent on IP driver versions and manufacturers specifications.
8. The IP video management system shall support up to 64 looping analog camera inputs with direct-attached 16-channel encoders; up to four direct-attached units. The direct-attached 16-channel encoders shall support H.264 compression, CIF, 2CIF, and D1 resolutions at maximum 30ips, 16 audio inputs and RS422/485 PTZ control with Pelco P and D protocols.
9. The IP video management system shall support an unlimited number of systems connected over a network. Each system shall contain two 1GB network ports; one for IP camera/encoder data, and one to connect to a network for client computer access.
10. The IP video management system shall be viewed, managed, and played back through a single user interface simultaneously with other Digital Sentry digital video management systems through supplied DS Admin or DS ControlPoint Client software.
11. The IP video management system shall operate on a 2nd Generation Intel® Core™ i7 processor and 8 GB of RAM.
12. The IP video management system shall utilize a Windows® 7 Ultimate 64-bit operating system.
13. The IP video management system shall support and have an option for an internal DVD+/-RW.
14. The IP video management system shall contain two DVI-D ports.
15. The IP video management system shall allow expansion of IP video channel capacity through a licensing without any hardware modification.
16. The IP video management system shall support multiple models of IP cameras and encoders including Pelco cameras and encoders with Sarix technology and multiple third-party manufacturers.
17. The IP video management system shall support audio recording from Pelco cameras with Sarix technology in addition to third-party manufacturer's audio recording.
18. The IP video management system shall support recording the internal server with additional storage utilizing SCSI attached Pelco DX8100-HDDI storage.
19. The IP video management system shall be capable of continuous scheduled alarm/event and motion recording. Pre- and post- alarm recording shall also be available and shall be fully programmable on a per channel basis.
20. The IP video management system shall allow archival of video data to computers or SAN storage devices over a network connection with the optional DS Archive Utility. The archival schedule shall be either automatic at user-defined intervals or manual and shall be configurable per connected camera.
21. The IP video management system shall support network health and monitoring utilizing third-party SNMP monitoring tools.
22. The IP video management system shall indicate system performance and operation status utilizing a variety of HTML reports.
23. The IP video management system shall display system health monitoring data utilizing front panel LED displays and display popups.
24. The IP video management system shall optionally support on-board video analytics in quantities of two or four channels with Active Alert software and the DS DataPoint

interface. The DS DataPoint interface shall provide video analytics monitoring including tracking and counting objects and people.

25. The IP video management system shall support Lightweight Directory Access Protocol (LDAP).

D. System Specifications

1.	Processor	2nd Generation Intel® Core™ i7
2.	Internal Memory	8 GB RAM
3.	Network	2 Gigabit Ethernet RJ-45 (1000Base-T)
4.	User Interface	DS Control Point
5.	Internal Storage	RAID 5
6.	DS-SRV	9 TB
7.	Raid Level	RAID 5 (required optional DS-SRV-RAID controller card)
8.	External Storage	Up to 24 TB JBOD or RAID 5 through DX8100HDDI
9.	System Drives	6, 3.5-inch hard drive bays, hot swappable
10.	PCI-E Slots	1 PCI-E x 16 and 1 PCI-E x 4
11.	Auxiliary Interfaces	
	a. USB Ports	1 front (USB 2.0), 4 rear (2 USB 3.0; 2 USB 2.0)
12.	Power Input	100 to 240 VAC, 50/60 Hz, Autoranging

E. Environmental

1.	Operating Temperature	10º to 35ºC (50º to 95ºF)
2.	Operating Humidity	20% to 80%, noncondensing
3.	Maximum Humidity Gradient	10% per hour
4.	Operating Altitude	–15 to 3,048 m (–50 to 10,000 ft)
5.	Operating Vibration	0.25 G at 3 Hz to 200 Hz at a rate of 0.5 octave/minute
6.	Dimensions	50.8 x 43.4 x 8.9 cm

F. Certifications

1. CE, Class A; meets EN50130-4 standard requirements
2. FCC, Class A
3. UL/cUL Listed
4. CCC
5. KCC

G. Remote Client Minimum PC Requirements

1.	Processor	2nd Generation Intel® Core i7 processor with integrated graphics
2.	Memory	4 GB or higher
3.	Operating System	Windows XP Professional SP2, Windows Vista (32 or 64 bit), Windows 7 (32 or 64 bit)

H. Warranty

1. 3 year parts and labor

I. Pelco Model #DSSRV-090DVD

J. Supplied Accessories

1.	Power Cord	1, all cables are 3 prong, molded connector, 1.8 m (6 ft)
2.	USB Keyboard and Mouse	1
3.	Bezel key	2
4.	Rack Mount Kit	Brackets, rails, and hardware for mounting in a rack
5.	DS-SRV-LIT	Documentation, resource and recovery disc
6.	DS-SVR-Raid	LSI 3Ware 9750-8i RAID controller card

2.6 IP VIDEO MANAGEMENT CLIENT

A. The IP video management system shall provide the capability of running a client application in additional to the video management system.

B. A client computer with system compatible software shall be the user interface for viewing one or more systems. Live and recorded video and current event video shall be displayed on any client computer using a proper login and password. The client computer shall be able to connect to an unlimited number of recorders simultaneously to display live and recorded video.

C. Client Software shall be unlicensed and available to be installed on as many clients as required by the user.

D. Client Software shall be password controlled such that password functionality set at each connected system will be recognized at the client. Password shall limit the ability to access live or recorded video as well as the ability to export video.

E. Client Software shall allow multiple monitor support for up to four displays per client workstation, providing virtual matrix functionality.

F. Client Software shall allow the connection of Pelco KBD5000 keyboard controllers to the client workstation to control PTZ operations and camera call-up.

G. Client Software shall allow video streams to be selectable from a system tree on an individual camera, individual system, client defined local groups, or from predefined recorder based groups.

H. Client Software shall be a tab based work environment with the ability to undock the tabs creating a virtual workspace on single or multiple monitor clients.

I. Client tabs shall include system management, live, and search options. Tabs can be displayed simultaneously on the client.

J. Systems Tab shall display and sort available systems, connection status, system names, system IP addresses, and custom categories. This tab shall additionally allow:

1. Manual connect and disconnect of systems to the client
2. Virtual systems naming
3. Auto Connecting
4. Adding, deleting, and editing available systems

K. Live video tab shall have the ability to be created up to four times on a single client workstation providing for video display combinations and simultaneous video streams from as many different systems with consideration for maximum client bandwidth. Live video tab shall provide the following functionalities:

1. Quick Review which shall display recorded video from the last 1, 5, 15, 30, 60 or 90 minutes, providing near instantaneous review of recent events
2. One week graphical display of recorded video
3. Borderless display option
4. Screen layout selection
5. On the fly on-screen display changes including time, date, camera name, frame rate, frame size, alarm display, and border indicators
6. Digital zoom
7. User selectable in-video PTZ control or dashboard style control
8. Drag and drop audio support associating any audio with any video

L. Search video tab shall allow for the search of one or multiple cameras from one or multiple systems simultaneously. Search tab shall provide the following functionalities:

1. Time and date search
2. Advanced data search with DataPoint interfaced software to Active Alert Intelligent Video and POS
3. Drag and drop audio support to associate audio with any video
4. Video export to any system accessible media including locally to HDD, CD/DVD, Flash USB device or to network storage
5. Video authentication of exported video via check sum verification

M. Alarm video tab shall allow for alarm pop-up and playback of active alarms. Alarms may be based on motion activity, an external software trigger from Active Alert analytics or a preset data alarm from DS DataPoint. An alarm list pane shall be displayed for playback of queued alarms.

N. The Client shall incorporate virtual matrix functionality whereby camera sequences may be created on the monitoring workstation with the following functionalities:

1. Each sequence shall have a maximum of 500 cameras
2. Each camera in the sequence shall have its own individual dwell time, from 1 to 60 seconds
3. Each entry in a sequence shall have the capacity to trigger PTZ camera presets, patterns, or auxiliaries
4. The Client shall have the capability to display recorded video with full VCR controls. This feature shall display video from multiple cameras simultaneously. The user shall be able to play video as fast as possible (all images), in real time, or by skipping a selectable number of seconds
5. The Client shall support simultaneous playback of up to sixteen cameras all synchronized with each other. Non-synchronous playback of multiple cameras shall not be acceptable
6. The Client shall support tours of multi-camera displays

2.7 NETWORK SWITCHES

A. General

1. Provide Ethernet, 10/100/1000 switches to network the cameras and the NVR together.
2. Provide a Cisco layer switch or equal.

B. Rack Mount Indoor Switches

1. Provide two (2) switches, one in the rack in Maintenance building, and one in the rack in Service wiring room.
2. Switches shall have the following features:
   a. Ethernet 10/100/1000
   b. 48 port
   c. 4 Gigabit SFP ports
   d. POE+ (740W)
   e. Integrated security to protect network traffic and to limit access.
   f. Network Monitoring capabilities and enhanced troubleshooting for connectivity issues.
   g. SNMP
   h. USB storage for file backup and simplified operations
   i. QOS
3. Provide the required transceivers
4. Provide any required licenses
5. Switches shall be Cisco WS-C2960S-48FPS-L or equal

2.8 COMPUTER/MONITOR

A. Provide one (1) computers for monitoring the system. One shall be located in the Operations area as directed.

B. Computer shall be AGS Mirador workstations designed to meet the demands of the video system. Model AGS-WSLE

1. Minimum System Requirements

a.	Tower:	Intel® certified 6 drive tower
b.	Motherboard:	Intel® 5500 Series Xeon w/2 CPU
c.	Processor:	Quad Core 5500 (16 Cores)
d.	Operating System:	Microsoft® Windows® XP Pro, Windows 7 Pro®, Vista Business
e.	Memory:	6 GB REG ECC (max 96GB)
f.	Storage:	250Gb
g.	Network Interface Card:	100/1000 Mbps
h.	Web Browser*:	Internet Explorer® 7.0 or later, Mozilla® Firefox® 3.5 or later, Internet Explorer 8.0 or later is recommended for configuring analytics
i.	Video:	Four video output for the connection of up to 4 monitors

C. Provide USB keyboard and mouse

D. Monitor.

1. Provide one monitor for the computer
2. Monitors shall be 19” flat panel TFT LCD monitors.
3. The flat panel monitor shall have a high definition 1280 x 1024
4. Shall allow for on-screen display for setup and adjustment of monitor parameters.
5. The flat panel monitor shall allow for multiple video inputs (front panel switchable), PC-compatible inputs, 2-BNC, DVI, S-Video and audio.
6. Brightness: 450 cd/m^2
7. Contrast Ratio: 1000:1
8. Backlight Type: 4 CCFL
9. Viewing Angle: 160°/160°
10. Response Time: 5ms
11. Panel Aspect Ratio: 5:4
12. Tilt: 0° to 30°
13. Speakers: Integrated
14. Input Voltage: 100-240 VAC, 50/60 Hz, autoranging
15. Power Consumption: Maximum 35 watts
16. AC Power Cord: Unit is supplied with grounded power cord; for 120 VAC
17. Operating Temperature: 50° to 104°F (10° to 40°C)
18. Humidity: 20% to 85%, noncondensing
19. Environment: Indoor
20. Construction: Black plastic
21. Finish: Black matte texture coat finish
22. Certification:
    a. CE, Class B.
    b. ETL listed to ANSI/UL 1950-1997.
    c. CETL listed to CAN/CSA C22.2 No. 950-95.
    d. FCC, Class B.
23. Monitors shall be Pelco PMCL419A

2.9 ENCLOSURES

A. CCTV Racks

1. Wall mounted
2. Sized as Required
3. Manufacturers: For convenience, details and specifications based on Cat. No. GL48WDS-25U by Great Lakes. Other manufacturers offering acceptable products include ADH Custom Metal Fabricators, Inc, Hoffman, Chatsworth, AMP or Hubbell.
4. Cabinet: 48 inch high x 24 inch wide x 32 inch deep, suitable for 19 inch wide equipment, with black anodized finish.
5. Solid, locking door
6. Adjustable mounting rails (2 pair)
7. Ground: Provide #6 minimum ground wire from data racks to the ground bar.
8. Provide 1 rack in the server room. Use the IT rack for equipment in the service area IT room.
9. Category 6 Patch Panels
    a. Manufacturers – For convenience, details and specifications based on:
        1) LAN568 Wiring Plan: LeGrand/P&S or equal by AMP, Panduit or Hubble.

b. Rack mounted unit, suitable for standard 19 inch equipment rack, providing interconnect between horizontal wiring and patch cable to switch.
c. Category 6, 48 port, wiring connection with (48) RJ45 connectors.
d. Provide one per rack.

10. Fiber Patch Panels
    a. Rack mounted by LeGrand/P&S or equal by AMP, Panduit or Hubble.
    b. Provide one 24 port Multimode and one 24 port Single-mode Panels in rack in room M111.
    c. Provide one 12 port Multimode panel in the rack in room E110
11. Provide one APC SMART-UPS RT 1500VA 120V .

PART 3 - EXECUTION

3.1 QUALITY CONTROL

A. All components of the CCTV system as a whole shall meet or exceed the minimum standards issued by the NTSC and EIA. All work in conjunction with this installation shall meet the requirements of the 2011 National Electrical Code.

B. The system shall be listed by Underwriter's Laboratories, Inc., and each of the major components shall bear the manufacturer's name, catalog number and U.L. label.

C. The Contractor shall provide necessary transient protection of the AC power feeding the CCTV system. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

3.2 INSTALLATION, WIRING AND RACEWAY

A. Preparatory work required to accommodate the CCTV system installation, i.e., conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required, shall be furnished and installed by the Contractor.

B. The CCTV system supplier shall provide expert supervision of the installation and in addition, shall furnish the necessary wiring diagrams and instructions required to make the final CCTV system installation complete.

C. The installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

D. The Contractor shall make installation in strict accordance with approved manufacturer's drawings and instructions.

E. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Engineer.

F. All equipment power wiring and grounding shall conform to the National Electrical Code and applicable local codes.

G. All electronic equipment shall be grounded.

H. All cable shall be installed in conduit.

I. Provide connectors specifically designed for the type cable in use.

3.3 WIRING

A. The Contractor shall furnish and install all wiring, conduit, back boxes, pull boxes, outlets and boxes for the erection and operation of a complete CCTV system as specified and described in these specifications, as shown on the drawings and recommended by the manufacturer.

B. All equipment power wiring shall be of the same type for lighting and power. Wiring shall meet the requirements of the National, State and local electrical codes.

C. All cameras located in and around the building shall be wired with Category 6 cable.

D. All wiring shall be in conduit.

E. Final connections between equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer of the equipment furnished. At the completion of the installation the manufacturer's representative shall test and adjust the system.

3.4 SYSTEM TEST AND ADJUSTMENTS

A. Before final acceptance of the CCTV system, the manufacturer/supplier of system shall, in presence of the Contractor and the Engineer, test each and every component and device in the system. The test shall be documented with signed copy submitted to the Contractor, the Authority and Engineer.

B. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and level controls to insure proper system operation.

C. The system commissioning shall include the setup of all cameras and the NVR. This shall minimally include the following:

1. Camera positioning to obtain the desired view
2. Focus and adjustment of the lens to obtain the desired view
3. Program the network switches for the appropriate operation for real time video
4. Program the NVR/cameras for the desired/appropriate resolution and frame rate
5. Program the NVR for the desired record times, etc
6. Program the NVR/camera analytics as appropriate for the viewing areas

D. The system shall be physically inspected by the Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.

3.5 INSTRUCTION ON SYSTEMS OPERATION

A. Upon completion of the work, and prior to acceptance of the same by the Owner, the Contractor and the major equipment manufacturer's qualified representative shall spend a minimum four

(4) hours on two (2) occasions, with the City facility personnel, instructing them on the operation and service of all the CCTV equipment and controls.

END OF SECTION

SECTION 28 3111

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. System smoke detectors.
3. Heat detectors.
4. Notification appliances.
5. Remote annunciator.
6. Addressable interface device.

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 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. Qualification Data: For qualified Installer.

D. Field quality-control reports.

E. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. 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.
7. Copy of NFPA 25.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

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 Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.8 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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fire Control Instruments, Inc.; a Honeywell company.
2. Fire Lite Alarms; a Honeywell company.
3. Gentex Corporation.
4. NOTIFIER; a Honeywell company.
5. Siemens Building Technologies, Inc.; Fire Safety Division.
6. 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:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.

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. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
4. Record events in the system memory.
5. Record events by the system printer.

C. 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.

D. 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.

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, 3 line(s) of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.

a. Initiating Device Circuits: Pathway Survivability Level 1.
b. Notification Appliance Circuits: Pathway Survivability Level 1.
c. Signaling Line Circuits: Pathway Survivability Level 1.
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.

2.4 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 hardwired-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. 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 (8 or 11 deg C) 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 (57 or 68 deg C).
    c. Provide multiple levels of detection sensitivity for each sensor.

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. Ionization Smoke Detector:

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.).

D. 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.

2.5 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 (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).

1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

D. 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- (25-mm-) high letters on the lens.

1. Rated Light Output:

a. 110 cd for weatherproof devices

b. Field selectable 15/30/75/110 cd

2. Mounting: Wall mounted unless otherwise indicated.
3. Flashing shall be in a temporal pattern, synchronized with other units.

4. Strobe Leads: Factory connected to screw terminals.
5. Mounting Faceplate: Factory finished, red.

2.7 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.8 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.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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 (9 m).
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 (1 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) 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. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

F. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

J. 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 Division 08 Section "Door Hardware." 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.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

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. 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. 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.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

DIVISION 31
EARTHWORK

SECTION 31 1000

CLEARING, PREPARATION, AND REMOVALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This technical specification covers the furnishing of all labor, materials, tools, and equipment necessary for clearing and grubbing of the project area in preparation for the construction activities described under this contract. Included in the work is the stripping, removal, and disposal of all trees, downed timber, snags, brush, vines, rubbish, stumps, logs, topsoil, and other incidentals that interfere with the planned construction.

1.2 DEFINITION

A. Clearing: Clearing shall consist of removing all vegetative matter such as trees, brush, downed timber, and other objectionable materials found on or above the surface of the site. It shall include: removing buildings, fences, and lumber; waste dumps and trash; salvaging of such materials as may be specified; and disposing of the debris as per public entity requirements. Scalping shall include the removal of material such as sod, grass, residue or agricultural crops, and decayed vegetative matter from the surface of the ground without removing more earth than is necessary. Perimeter erosion and sediment controls must be in place before clearing activities occur.

B. Grubbing: Grubbing shall consist of removing and disposing of all vegetative matter such as stumps, roots, buried trees, and brush encountered below the surface of the ground of subgrade, whichever is lower, that has not been included in the description of clearing.

In all cases of grubbing, the vegetative matter shall be removed to a minimum depth of 12 inches below ground line or subgrade, whichever is lower, except as provided in the description of demolition and removal.

When deleterious materials are encountered below the ground line which may be detrimental to the proposed improvement, they shall be removed to a depth necessary to provide adequate support for the proposed improvement.

C. Trees: Vegetable growth 6 inches (15.24 cm) in diameter and larger, measured 3 feet (91.44 cm) above ground shall be classified as a tree.

D. Brush: Vegetable growth less than 6 inches (15.24 cm) in diameter, measured 3 feet (91.44 cm) above ground shall be classified as brush.

1.3 CONSTRUCTION SPECIFICATIONS

A. Limits of Work: The limits of clearing, and grubbing shall extend to the construction limits unless otherwise shown on the plans. Clearing should only occur in those areas required for construction within a six month period. Where possible, large projects should be cleared and grubbed as construction progresses. Mass clearing and grubbing should be avoided. An undisturbed strip of not less than 25 feet in width of existing grass or other vegetation should

be kept in place around the perimeter of the construction site, where possible, and protected from damage. The Contractor shall scalp only those excavation and embankment areas necessary for construction of the project.

Perimeter Erosion and Sediment Controls: Perimeter controls will be put in place prior to the start of clearing and grubbing of the site. It is possible some clearing and grubbing will need to be done to accommodate the installation of some perimeter controls.

B. Embankment Areas: Where undisturbed stamps and roots are encountered where the fill depth will exceed 3 feet, the stumps and roots may be left in place provided they do not extend more than 3 inches above the original ground line

C. Backfilling the Site: All trenches, holes, and pits areas resulting from clearing, and grubbing, or removal on the site shall be backfilled with suitable material placed and compacted.

D. Disposal of Materials: All materials, with the exception of those that are designated for salvage or embankment, shall become the Contractor's property and shall be disposed of by the Contractor, outside the project limits

PART 2 - SITE PREPARATION

2.1 CONSTRUCTION SEQUENCE SCHEDULE

A. Description: A construction sequence schedule is a specified work schedule that coordinates the timing of land-disturbing activities and the installation of erosion and sediment control measures.

B. Application: A construction sequence schedule reduces on-site erosion and off-site sedimentation by performing land-disturbing activities and installing erosion and sediment control practices in accordance with a planned schedule.

C. Construction Specifications: Many timely construction techniques can reduce the erosion potential of a site such as shaping earthen fills daily to prevent overflows and constructing temporary diversions ahead of anticipated storms. These types of activities cannot be put on the construction sequence schedule but should be used whenever possible.

D. Following a planned construction sequence schedule to reduce erosion should help keep field personnel aware of the possibilities of erosion prevention through construction management and reduction in the total area disturbed at any one time.

E. Inspection and Maintenance: Follow the construction sequence throughout project development. When changes in construction activities are needed, amend the sequence schedule in advance to maintain management control.

END OF SECTION

SECTION 31 2000

EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The following are minimum requirements and shall govern, except that local, state and/or federal codes and ordinances shall govern when their requirements are in excess hereof.

1.2 SUMMARY

A. Work Included: Furnish labor, material and equipment necessary to complete site earthwork, as shown and specified, to include, but not limited to the following:

1. Excavation, filling, grading and subgrade preparation for site work, site utilities, buildings, and pavements.
2. Disposal of excess and waste materials (including oil contaminated soils, if encountered).
3. Preparing subgrades including cut and fill for building slabs, slabs on grade, exterior pavements, lawns and grasses and exterior plants.
4. Subbase course for support of building slabs.
5. Subbase and/or base course for concrete pavements and asphalt paving.
6. Excavating and backfilling of trenches within building lines.
7. Excavating and backfilling for underground storm, sanitary, water, gas and electrical piping/conduits and related buried mechanical and electrical appurtenances.
8. Temporary earth retaining structures as necessary to maintain the integrity of the excavation and prevent settlement of adjoining structures.

B. Related Sections include the following:

1. Division 01 Sections "Quality Requirements" and “Special Inspections and Structural Testing” for independent testing agency procedures and administrative requirements.
2. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
3. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
4. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
5. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
7. Division 33 Section "Subdrainage" for drainage of walls and landscaped areas.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Slab Subbase Course / Drainage Course: Aggregate layer supporting the building slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owners Representative. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owners Representative. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Warning tapes.
3. Flowable fill material, including design mixture.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329, ASTM D 3740, and ASTM E 548 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site.

1.6 FIELD INSPECTION TESTING AND QUALITY CONTROL

A. Owner shall employ and pay for a qualified, independent Special Inspector and geotechnical Testing Agency, to perform soil testing and inspection services during earthwork operations including all backfill and subgrade preparation.

1. Testing Agency Qualifications: To qualify for acceptance, the geotechnical Testing Agency must demonstrate to Architect's/Engineer's satisfaction, based on evaluation of laboratory submitted criteria conforming to ASTM E699 and E329, that it has the experience and capability to conduct required field and laboratory geotechnical testing without delaying the progress of the work.

B. The service of this Testing Agency is intended for the Owner's verification and shall in no way relieve the Contractor of his responsibility to be in compliance with the requirements of the Contract Documents and to provide his own inspection and quality control.

C. Laboratory Tests:

1. Existing site material:

    a. Cohesive soils and semi-cohesive soils: Provide one optimum moisture-maximum density curve for each type of subgrade soil encountered in accordance with ASTM D698.
    b. Non-cohesive soils: Provide maximum and minimum index densities and relative densities for each type of subgrade soil encountered in accordance with ASTM D4254.

2. Borrow materials: Analyze each type of borrow materials before acceptance and delivery to the site. Any change in the source or quality of the material will require a new series of tests to determine acceptability.

    a. Particle size analysis of soils ASTM D422, ASTM D421, ASTM D420, ASTM C117 recommended practice.
    b. Plasticity index determination ASTM D4318.
    c. Moisture-density curve determination ASTM D698 or relative density (ASTM D4253 or ASTM D4254) as specified above.
    d. Frost susceptibility analysis.

D. Field Tests:

1. The Special Inspector and Soils Testing Agency representative shall be present during delivery and compaction of all fill materials.
2. Establish suitable bearing grades for foundations and structural fill below foundations and slabs on grade.
3. Verify natural soil and structural fill subgrades for all foundations for a minimum design bearing pressure of 1500 PSF.
4. In-place density tests: one test group consists of compaction tests on each layer of fill and backfill material. Test in accordance with ASTM D1556 (sand cone method), ASTM 2167, ASTM 2922 and ASTM 2937, as Applicable on compacted fill materials as follows:

    a. One test at each column foundation per 8” lift.
    b. One test along wall foundations, at maximum 200 ft. intervals, per 8” lift, but in no case fewer than two tests.
    c. One test for each 2000 sq. ft. of slab on grade and pavement subgrade per 8” lift but in no cases fewer than three tests.
    d. One test for each 200 cu. yd. of fill and backfill at exterior side of foundation walls and unpaved areas.
    e. One test for every 300 feet of fill and backfill of pipe trench in City Right of Way
    f. One test for every 100 feet of Public Roadway

5. Verify and monitor all compaction operations and equipment.
6. Monitor all proof-rolling operations for foundation, slab on grade and pavement subgrades.

E. All tests on borrow materials shall be performed before acceptance and delivery of fill to the site. Any change in the source of material or change in quality of the material will require a new series of tests to determine acceptability.

F. Delivery and compaction of fill material shall be made during the presence of the Special Inspector and Soils Testing Agency and shall be subject to their approval. This inspection by no means absolves the Contractor from responsibility of compaction as specified.

G. An alternative appropriate density test procedure shall be determined by the Special Inspector and Soils Testing Agency to obtain the maximum density where material gradations do no permit use of ASTM D698.

H. All earthwork operations shall be performed by personnel experienced in these operations. It is the responsibility of the Contractor to provide such personnel.

I. Soil test shall determine fertilizer application rates for the establishment of grass on the site.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Owners Representative.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures are in place.

E. Do not commence earth moving operations until plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.8 USE OF EXPLOSIVES

A. Explosives: Use of explosives will not be permitted.

1.9 CODES AND STANDARDS

A. Perform excavation work in compliance with applicable requirements and codes of authorities having jurisdiction.

B. Perform earthwork items in conformance with the Virginia Department of Transportation's standard specifications unless otherwise specified herein.

1.10 COOPERATION

A. Examine drawings and specifications for other contracts, to determine nature of proposed construction. Perform work to conform with construction called for in such a manner as not to interfere or delay work of other Contractors.

B. Protect and maintain benchmarks, monuments or other established reference points and property corners. If disturbed or destroyed, the contractor shall hire a Professional Land Surveyor licensed to provide survey in the Commonwealth of Virginia at the expense of contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Common Earth Fill

1. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
2. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups, soils which contain rock or gravel larger than 3 inches in any dimension, debris, organic matter, waste frozen materials, vegetation, and other deleterious matter. Unsatisfactory soils also include satisfactory soils not maintained within 2-percent of optimum moisture content at time of compaction.

C. Sand:

1. Comply with ASTM C33; fine aggregate.

D. Bedding Material:

1. Shall be VDOT #57, #68, or #78 stone.

E. Drainage Material

1. Shall be VDOT #57.
2. Stone shall be narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel.

F. Foundation Stone

1. Foundation stone for foundation/trench stabilization material shall be VDOT #1 or #2 stone.

G. Pavement Base Course

1. Shall be VDOT Type I, size 21A or 21B.

H. Dense Graded Aggregate Backfill

1. Shall be VDOT Type I, size 21A

I. Subbase Material

1. Comply with VDOT standards, size designation 1. Slag not permitted.
2. Clean, hard, sound, durable, uniform in quality and free from any organic or deleterious materials, with the following gradation requirements:

Sieve Size	Percent Passing
1"	100
1/2"	90 - 100
1/4"	0 - 15

J. Subbase Material Type II/Select Earth Backfill

1. Approved on-site or borrow material consisting of satisfactory soil materials free of clay, rock or gravel larger than 1" in any dimension, ice, snow, wood, masonry, rubble, concrete trash, debris, organic material or other deleterious materials.

K. Subbase Material Type III/Crusher Run

1. Material shall comply with VDOT standards. Slag not permitted.
2. Clean, hard, sound, durable, uniform in quality and free from any organic or deleterious materials, with the following gradation requirements:

Sieve Size	Percent Passing
2"	100
1/4"	25 - 60
No. 40	5 - 40
No. 200	0 – 10

L. Flowable Fill/Structural Backfill

1. Minimum f’c = 150 psi.

M. Herbicide Treatment

1. Commercial chemical for weed control that is registered with the Environmental Protection Agency. Provide granular, liquid, or wettable powder form, labeled for use under asphaltic concrete pavement surfaces. Materials shall not damage trees and plants adjacent to pavement surfaces.

N. Rip Rap Stone

1. Shall be VDOT Class AI, I, II or III as designated on the construction drawings

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

2.3 GEOTEXTILES

A. Subsurface Drainage Geotextile (to be used in drains): Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288.

B. Separation Geotextile (to be used under foundations, slabs and pavements): Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contractor shall plan construction to minimize disturbance to properties adjacent to the project site and be within the construction limits shown on the plans.

B. Contractor shall obtain written permission from property owners for use of any access other than ones located within rights-of-way or GLTC property. Written permission shall contain conditions for use and restoration agreements between property owner and Contractor.

C. All areas disturbed shall be restored to a condition equal to or better than their original condition and shall be graded to drain.

D. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

E. Protect and maintain erosion and sedimentation controls during earth moving operations.

F. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system, to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 24 inches outside of concrete forms other than at footings.
    b. 12 inches outside of concrete forms at footings.
    c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. 6 inches beneath bottom of concrete slabs-on-grade.
    f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 incheswide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.

B. Where uncontrolled fill, soft, loose or yielded material exists, these areas must be undercut a minimum of 2'-0". Further undercut any areas which do not stabilize and replace with approved compacted fill.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

A. Notify the Owner's Testing Agency when excavations have reached required subgrade.

B. If the Owner's Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner's Testing Agency, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner's Testing Agency, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2000 psi, may be used when approved by Owners Representative.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Owner's Testing Agency.

3.10 STABILITY OF EXCAVATIONS (includes open excavation and all site utility trench excavation.)

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction. Provide shoring and bracing where necessary to protect existing structures, utilities, improvements, utility excavation or all other excavations against loss of ground or caving embankments.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies 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. Excavation limits per OSHA.

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.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile excavated soil materials acceptable for backfill and fill where directed. Place, grade and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.

3.12 COMPACTION EQUIPMENT

A. It is the responsibility of the Contractor to select, furnish, and properly maintain equipment that will compact the subgrade and fill uniformly to the required density.

B. The Contractor shall have at the site at all times during earthwork operations, a smooth steel wheel roller, with a rated capacity of at least 10 tons, which shall be used to seal the surface of the fill at the close of each working day, and at other times when directed by the Owners Representative to prevent infiltration of precipitation and surface water into the fill material.

C. Excavation to final subgrade shall not proceed and no fill shall be placed until approved compaction equipment is on the site and in working condition.

3.13 PROTECTION OF EXCAVATIONS AND SUBGRADES

A. Protect excavation bottoms and subgrades against freezing when atmospheric temperature is less than 35 degrees F.

B. Contractors will take every precaution during final stages of excavation to prevent disturbance of the natural soil at proposed subgrade elevations. Such precautions shall include, but not be limited to, keeping equipment off final subgrade during the last several feet of excavation and using excavating buckets without teeth.

C. Additional excavations, undercutting and/or backfilling operations resulting from failure to properly protect accepted subgrades shall be done at the expense of the Contractor.

3.14 COMPACTION OF THE NATURAL SUBGRADE BENEATH FOUNDATIONS

A. Following completion of the excavation to the required lines and grades beneath proposed foundations, the natural subgrades must be compacted and must be tested and accepted by the Soils Testing Agency prior to the placement of backfill material. For areas with granular soils, use a Dynapac-25 or equal. For areas with silty or clayey areas, proof-roll with the vibrations turned off or use a static roller such as a smooth drum steel roller or sheepsfoot roller.

B. Areas, which exhibit soft or unsuitable conditions, must be undercut and removed. The removed material must be replaced with approved compacted backfill.

3.15 FILLING AND BACKFILLING

A. Preparation

1. Subgrades must be tested and approved by the Soils Testing Agency before placing fill and/or backfill.

2. Below finish grade construction, including, where applicable, dampproofing, and perimeter insulation, shall be acceptable by the Owners Representative prior to placing fill and/or backfill.
3. Remove concrete formwork, shoring, bracing, cut off temporary sheet piling and backfill all voids prior to placing fill and/or backfill.

B. Use of Materials

1. Common Earth Fill
   a. Fill and backfill exterior side of structures to subgrade where no slab on grade, no pavement, and no foundation drain systems occur.
   b. Site fill where no pavement occurs.
   c. Fill and backfill to subgrade at site trenches where no slab on grade or pavement occurs.
   d. Fill and backfill to subgrade where demolition is required and no foundations, slab on grade, or pavement occurs.
   e. Fill and backfill in areas not specified on drawings.

2. Sand
   a. Fill and backfill for underground tanks.
   b. Bedding for storm, sanitary, water, gas and electrical utility trenches.
   c. Backfill above foundation drains as detailed.

3. Bedding Material

   a. Bedding for storm, sanitary, water, gas and electrical utility trenches.

4. Drainage Material

   a. Backfill foundation drainage lines and site underdrain lines enclosed within an approved soil separation fabric.
   b. Backfill at site trenches where pavement occurs.

5. Foundation Stone

   a. Clean well-graded stone, authorized by the Engineer, used to strengthen and/or provide support to an otherwise weak subgrade. Foundation stone is placed, and the subgrade improved before bedding stone is placed.

6. Base Course for Pavements

   a. Base course for pavements, site slabs, and site steps.

7. Subbase Material, Type I

   a. Subbase material below vapor barriers for slab on grade construction.
   b. Fill and backfill below base course for pavements, site slabs and site steps.
   c. Fill and backfill for underground tanks.
   d. Backfill at site trenches where pavement occurs.

8. Subbase Material, Type II

   a. Fill and backfill below base course for pavement, site slabs and site steps.

9. Subbase Material, Type III (Crusher Run Stone)

a. Fill and backfill beneath foundations.
b. Fill and backfill beneath subbase material specified for slab on grade construction.
c. Fill and backfill building against building walls and site structures adjacent to pavement.
d. Backfill at site trenches where pavement occurs.

10. Flowable Fill

a. Fill and backfill for storm, sanitary, water, gas and electrical utility trenches.
b. Fill and backfill beneath foundations.
c. Fill and backfill beneath subbase material specified for slab on grade construction.
d. Fill and backfill against building walls where no foundation drainage systems occur.

3.16 PLACEMENT AND COMPACTION OF FILL MATERIALS

A. Ground Surface (Subgrade) Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

1. When existing ground surface has a density less than that specified for a particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

B. Do not place any fill material when the fill, the previous lift of fill, or the subgrade on which it is to be placed is frozen. In the event that any fill which has been placed or the subgrade becomes frozen, it shall be scarified, as required to break up the frozen material, and recompacted or removed to the satisfaction of the Soils Testing Agency. Any soft areas resulting from frost shall be recompacted or removed to the satisfaction of the Soils Testing Agency.

C. Place loose 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.

D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

E. Underslab fill and backfill shall be placed and compacted before installation of underfloor mechanical and electrical lines. Underslab subbase material shall be installed after underslab mechanical and electrical lines have been installed, backfilled, and compacted.

F. Avoid routing of construction equipment, including loading trucks, over acceptable subgrade or compacted areas. Should routing of heavy equipment occur over such areas, the Contractor shall be responsible for any adverse effects incurred.

G. Uniformly spread each layer, moisten or dry as required for optimum moisture content and then compact so density of the compacted material meets or exceeds the specified percentages below.

Percentage of Maximum Dry Density per ASTM D 698	Location
98	Beneath all foundations and within in 25’ of building

95	Above foundations
95	Below slab on grade construction, pavements, shoulders, sidewalks, curb and gutter, and cobbles/Belgium Blocks
90	Non-loaded vegetative areas (lawn, plantings, etc.)

H. Any lift, or portion thereof, which is not compacted in accordance with the Specifications shall be recompacted or removed and replaced to the satisfaction of the Soils Testing Agency. The degree of compaction of each lift shall be checked by the Soils Testing Agency, and each successive lift shall not be placed, or compacted, until the previous lift is tested and approved by the Soils Testing Agency. Fill shall be compacted to the lines and grades specified.

I. Acceptance and rejection of fill placed in accordance with 98%, 95% and 90% (as specified) of maximum density attainable by the Standard Proctor Method of Compaction (ASTM D-698) and other requirements as stated in these specifications.

1. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

   a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
   b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

J. Flowable fill material to be mixed and placed in conformance with VDOT standards.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. Provide positive drainage away from building and retaining walls

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.18 UTILITY TRENCH BEDDING AND BACKFILL

A. General

1. Minimum Cover: Unless shown otherwise on the construction documents, provide minimum trench depth indicated to maintain a minimum cover over the top of the installed item. Minimum cover on pipe is measured from top of pipe to original ground or proposed finished grade as applicable and shall be per standard details.
2. Remove all material from trench limits. Material of a compactible nature that can be re-used as trench backfill shall be re-installed and re-compacted to the requirements set forth in these specifications.
3. At the Contractor's expense, dispose of all unsatisfactory material, of whatever nature, to a site which legally can accept such material as fill. Adhere to all applicable laws and ordinances regarding permitting of waste site, erosion control, zoning, etc. as may be applicable.
4. Material of an uncompactable nature, material unsatisfactory for backfill, trash and excess material shall be removed from project site and disposed at the Contractor's expense.
5. Where the utility line is in an existing paved area, the pavement shall be saw cut in a straight line parallel to the pipe on each side. Saw cutting operations shall be performed prior excavation to avoid excessive removal of asphalt. Care shall also be taken during the installation of pipe to avoid damage to adjoining paved surfaces.
6. All trenches shall be excavated to the lines and grades as shown on the plans. Trenches for water lines may be curved within the limits of curvature of the pipe as allowed by AWWA C600.

    a. Trench Width: The sides of trench shall be uniform and vertical. See Standard Detail 27.01 for trench width for sanitary sewers and storm sewers and Standard Detail 26.01 for water lines.
    b. Trench Depth: All trenches shall be excavated to accommodate the bedding as required in Table 1 and shown in Standard Details 27.01 and 26.01 as applicable.

7. In excavating for the trench, it is essential that the trench bottom be uniform in grade and remains static during backfilling and under all subsequent trench conditions. The grade of the bottom of the trench shall be graded to within 0.04 foot (1/2-inch) of the plan specified grade. The stone shall be graded to the same tolerance.

B. Preparation of Trenches

1. Gravity Pipelines
   Depending upon the bedding class, the bottom of the trench for gravity pipelines shall be excavated to a minimum over depth as indicated in Table 1 to provide for improved pipe bedding material for the entire length of the gravity pipeline, including sewer lateral connections, except in rock where bedding shall be a minimum of 6 inches deep (see Standard Detail 27.01). Rock larger than 3 inches shall be removed from the trench bottom and any voids filled with soil or clean stone. The bedding shall be shaped so that the bottom quadrant of the pipe rests on the bed. Bell holes and depressions as required of the joint shall be dug after the bedding has been graded and shaped, and shall be only of such length, depth, and width as required for properly making the particular type of joint. The trench for sanitary sewers, sanitary sewer lateral connections, and storm drainage lines shall then be backfilled as indicated.
2. Water Mains
   When bedding is required, the bottom of the trench for pipe line shall be excavated to a minimum over depth as indicated in Table 1. The trenches for water lines shall be graded to avoid local high points. Trenches shall be graded either level or on a continuous upslope to the high points designated on the drawings. Trenches shall be of such depth as to provide a minimum cover. Pipe shall not bridge any areas. Rock larger than 3 inches shall be removed from the trench bottom and any voids filled with soil or clean stone. Bell holes shall be provided at each joint to permit proper joint assembly and proper pipe support. Rock shall

be removed 6 inches below pipe and bedding shall be a minimum of 6 inches. The trench for water lines shall then be backfilled as indicated.

C. In areas where trenching for pipes will be in fills, the fills shall be brought to an elevation of at least 12 inches above the top of the pipe, and then the trench excavated in the compacted fill, as herein specified for trench excavation.

D. Excavation for Appurtenant Structures

1. Excavate for appurtenant structures to provide at least 12 inches (minimum) clear distance between outer surface of the structure and undisturbed earth.
2. Where rock is encountered so that a built-in-place manhole, precast structure (such as a manhole or vault), or other structure will bear over rock, remove the rock to a minimum of 12 inches below the foundation or footing of the structure and place an 12-inch cushion of VDOT #57 stone over the rock.

E. Bedding

1. Class D Bedding is that condition existing when the ditch is excavated slightly above grade by excavation equipment and cut to finish grade by hand. Bell holes are dug, to prevent point loading the pipe bells, so that pipe bears uniformly upon the trench bottom. Existing soil should be shovel sliced or otherwise compacted under the haunching of the pipe to provide some uniform support. The backfill to the ground surface is to be compacted to the density specified in Table 1. In poor soils, granular bedding material is generally a more practical, cost effective installation. The bedding factor for class D bedding is 1.1.
2. Class C Bedding is that condition where the pipe is bedded in compacted granular material. The granular bedding has a minimum thickness of one-eighth the outside pipe diameter, but not less than 4 inches or more than 6 inches, and shall extend up the sides of the pipe one-eighth of the pipe outside diameter. The backfill to ground surface is to be compacted to the density specified in Table 1. The bedding factor for class C bedding is 1.5
3. Class B Bedding is that condition where the pipe is bedded in carefully compacted granular material. The granular bedding has a minimum thickness of one-eighth the outside pipe diameter, but not less than 4 inches or more than 6 inches, between the barrel and the trench bottom, and covering the full width of the trench and shall extend to the spring line.
   The haunch area of the pipe must be fully supported; therefore, the granular material should be shovel sliced or otherwise compacted under the pipe haunch to the springline of the pipe. Both granular haunching (to the springline) and initial backfill to a minimum depth of 12 inches over the top of the sewer pipe should be placed and compacted. The remainder backfill to the ground surface is to be compacted to the density specified in Table 1. The bedding factor for class B bedding is 1.9
4. Class B-1 Bedding (PVC pipe applications) is the same as Class B Bedding except that granular backfill is placed to the top of the pipe rather than to the springline of the pipe. The backfill to the ground surface is to be compacted to the density specified in Table 1
5. Class A Bedding is that condition when the pipe is bedded in a cast-in-place cradle of either plain or reinforced concrete having a thickness equal to one-fourth the inside pipe diameter, with a minimum of 4 inches and a maximum of 15 inches under the pipe barrel and extending up the sides for a height equal to one-fourth the outside pipe diameter. The cradle width shall have a width at least equal to the outside diameter of the sewer pipe barrel plus 8 inches. The bedding factor for class A bedding is 2.2.
   The haunching and initial backfill material above the concrete cradle should be crushed stone or a well graded granular material and carefully compacted to 12 inches above the crown of the pipe. The backfill to the ground surface is to be compacted to the density specified in Table 1.

F. Minimum Bedding Requirements

Table 1			
Minimum Bedding Class			
Application	**Pipe Material**	**Pipe Size**	**Minimum Bedding Class**
Sewer			
	PVC	6-inches or smaller	Class B-1[a] (stone to top of pipe)
	PVC	8-inch thru 15-inch	Class B-1[a] (stone to top of pipe)
	DIP	4-inch thru 24-inch	Class C
	RCP	> 24-inch	Class C
Water			
	DIP	up to 16-inch	Class D
Storm			
	RCP inside R/W	Thru 36-inches	Class C
	RCP outside R/W	Thru 36-inches	Class D
	PCP outside R/W	Thru 24-inches	Class D
	RCP	> 36-inch	Class C
	DIP	15-inch thru 24-inch	Class C

[a]The approximate long-term deflection in different burial conditions (bedding classes, depth, degree of compaction, type backfill soil, etc.) generally can be calculated using the Modified Iowa Formula developed by Spangler and Watkins.

1. When rock is encountered excavate to a depth of 6 inches below pipe and provide granular pipe bedding at a depth of 6 inches between pipe barrel and trench bottom. The bedding shall extend up the sides of the pipe 1/8 of the pipe outside diameter.

2. The bottom of structure excavations shall be excavated to minimum over depth of 12 inches below the bottom of the structure to provide for stone bedding. Bedding material shall be shaped and graded so that the entire bottom of the structure rests on the material for its entire area.

G. Backfilling

1. General

   a. Reopen trenches that have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified.
   b. Should any of the work be so enclosed or covered up before it has been approved and inspected, uncover all such work and, after approvals have been made, refill and compact as specified.

c. Observe specific pipe manufacturer's recommendations regarding methods of backfilling and compaction.
d. All trenches shall be backfilled prior to the completion of the day's work
e. Exercise extreme care in backfilling operations to avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion. Repair damages, distortions, or misalignments

2. Methods

a. Select Earth Backfill: Furnish select earth backfill where indicated on drawings and specified for compacted backfill conditions up to 12 inches above top of pipe. Comply with the following:

1) Care shall be taken to prevent any disturbance to the pipe or damage to newly made joints. The filling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressures do not occur such that the pipe could be displaced or dislodged. Do not backfill on muddy or frozen soil.
2) Sheeting and shoring generally should be removed only when the trench below it has become substantially filled, and every precaution shall be taken to prevent any slides of material from the sides of the trench onto or against the pipe.
3) Hand place, shovel slice, and pneumatically tamp all select earth backfill.
4) Place backfill in lifts not exceeding 8 inches (loose thickness).

b. Common Earth Backfill: Comply with the following:

1) Unless otherwise specified, backfill the remainder of the trench, from 1 foot above the pipe to grade, with common earth fill. Before placing any backfill, all rubbish, forms, blocks, wires, or other unsuitable material shall be removed from excavation. The backfilling shall be placed in layers not over 8 inches.
2) All areas within the limits designated on the drawings, including adjacent transition areas, shall be uniformly graded. The Contractor shall finish surfaces within the specified tolerances with uniform levels or slopes between points where elevations or existing grades are shown.

a) Finish subgrade areas that are to receive topsoil. Bring such areas to within 0.10 foot of required subgrade elevations.
b) Shape subgrade under sidewalks to line, grade, and cross-section. Subgrade is to be brought to within 0.10 foot of required subgrade elevations.
c) Shape subgrade under pavement and concrete slabs to line, grade, and cross-section. Bring to within ½ inch of required subgrade elevations.

3) The Contractor shall protect newly graded areas from traffic and erosion and repair and re-establish grade in settled, eroded, or rutted areas. Where compacted areas are disturbed by subsequent construction or adverse weather, the Contractor shall scarify the surface, reshape, and re-compact to the required density. In case of emergency, the City may refill any dangerous depressions without prior notice to the Contractor in the Right of Way.

c. Structure Backfill: Take care to prevent wedging action of the backfill against structure by carrying the material uniformly around the structure so approximately the same elevation is maintained in each lift. The Contractor shall refill all excavations as

rapidly as practical after completion of the structural work therein, or after the excavations have served their purpose.

d. Aggregate Backfill:

1) Dense Graded Aggregate Backfill: When select earth backfill/borrow cannot be obtained, dense graded aggregate may be substituted with the Engineer's approval.

3.19 HERBICIDE TREATMENT

A. Apply herbicide to compacted, dry subgrade prior to placement of stabilization fabric or base course. Apply herbicides in strict accordance with manufacturer application requirements and recommended rates. Comply with all applicable regulations for types of chemicals applied.

3.20 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

   a. Turf or Unpaved Areas: Plus or minus 1 inch.
   b. Walks: Plus or minus 1 inch.
   c. Pavements: Plus or minus 1/2 inch.

3.21 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.22 SUBBASE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact subbase course under cast-in-place concrete slabs-on-grade as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place subbase course 6 inches or less in compacted thickness in a single layer.
3. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of subbase course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.23 RIP-RAP

A. Provide rip-rap over soil separation fabric as indicated on Drawings.

B. Foundation Preparation: Areas on which rip-rap is to be placed shall be trimmed and dressed to conform to cross sections shown on the drawing within an allowable tolerance of plus or minus 2 inches from the theoretical slope lines and grades. Where such areas are below the allowable minus tolerance limit they shall be brought to grade by filling with acceptable backfill material, similar to the adjacent material and well compacted or by filling with bedding material and no additional payment will be made for any material thus required. Immediately prior to placing rip-rap, the prepared base will be inspected by the Architect/Engineer and no material shall be placed thereon until that area has been accepted.

C. Placement: The stones shall be placed so that the dimension approximately equal to the layer thickness is perpendicular to the slope surface and that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest stones shall be placed at the bottom of the slope. The rip-rap shall be properly aligned and placed so as to minimize void spaces between adjacent stones. The spaces between the stones shall be filled with spalls of suitable size.

D. Maintenance: The Contractor shall maintain the rip-rap protection until accepted and any material displaced by any cause shall be replaced at his expense to the lines and grades shown on the drawings.

1. Protect finish graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded and damaged areas.

3.24 FIELD QUALITY CONTROL

A. Allow Special Inspector and testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

B. Testing shall be performed as defined in Section 1.6 of this specification.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.25 EROSION CONTROL

A. Comply with all local requirements and with the latest version of the Virginia Erosion and Sediment Control Handbook.

3.26 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owners Representative; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.27 SALVAGE OF USEABLE MATERIALS

A. Useable materials include paving blocks, Belgium blocks, Bluestone, brick, castings, and pipe etc., removed during excavation that are useable on this project or future projects as determined by the City Engineer. Such material shall be stockpiled on site or as directed by the City Construction Coordinator at no additional cost to the City. Unnecessary abuse and damage to these items shall be the Contractor’s responsibility and the cost of replacement may be deducted from the retainage.

3.28 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Excavated contaminated soil, if found, and as designated by the Soils Testing Agency shall be segregated from all other excavated soils, and stockpiled on site on two (2) 6 mil polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Disposal of excavated contaminated material shall be in accordance with State and Local requirements.

3.29 CLEANING

A. Upon completion of earthwork operations, clean areas within contract limits, remove tools and equipment. Provide site clear, clean, free of debris, and suitable for site work operations.

END OF SECTION

SECTION 31 2319

DEWATERING

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 construction dewatering.

B. Related Sections:

1. Division 31 Section "Earth Moving" for excavating, backfilling, site grading, and for site utilities.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades and trench bottoms.

1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades, trench bottoms, and permanent structures is prevented.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

1.4 SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

1. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 2 - PRODUCTS *Not Used*

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 dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades and trench bottoms, and from flooding site and surrounding area.
2. Protect subgrades, trench bottoms, and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 01 Section "Temporary Facilities and Controls" Division 31 Section "Site Clearing" during dewatering operations. Unfiltered water from dewatering operations shall not be directly discharged to jurisdictional wetlands, Waters of the United States, or Waters of the Commonwealth of Virginia.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades and trench bottoms. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade or trench bottom softening, and slope instability.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

E. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

F. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 FIELD QUALITY CONTROL

A. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION

SECTION 31 2500

TEMPORARY EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work shall consist of furnishing, installing, inspecting, maintaining, and removing soil erosion and sediment control measures as shown on the contract documents or as ordered by the Engineer during the life of the contract to provide soil erosion and sediment control. This work shall be coordinated with the soil erosion and sediment control features specified elsewhere in the contract documents to the extent practical to assure effective and continuous soil erosion and sediment control throughout the construction and post construction period.

1. Erosion Control: The following items of work are provided in this section to address soil erosion control - mulch, straw/wood fiber mulch, seed and mulch, seed and straw/wood fiber mulch, all classes and types of rolled erosion control products, and soil stabilizers. Other items may be provided in the contract documents to provide soil erosion control (e.g., turf establishment, bank and channel protection, etc.).
2. Sediment Control: Sediment control is any action taken or item used as part of a project or as a separate action to minimize suspended solid material transport by water. The following items of work are provided in this section to address sediment control - silt fence, diversion dike, inlet protection, outlet protection, etc.

B. Related work specified elsewhere:

1. Section 312000 – Earth Moving.
2. Section 312319 – Dewatering.

1.2 DEFINITIONS

A. Erosion Control: Erosion control is any action taken or item used as part of a project or as a separate action to minimize the destructive effects of wind and water on surface soil. The use and placement of temporary diversion dikes, diversion ditches, mulches, sediment traps, sediment basins and drainage systems may be temporary and used throughout construction, or permanent and installed for the anticipated life of the facility.

B. VESCP – Virginia Erosion and Sediment Control Program authority" or "VESCP authority" means an authority approved by the Board to operate a Virginia Erosion and Sediment Control Program. An authority may include a state entity, including the Department; a federal entity; a district, county, city, or town; or for linear projects subject to annual standards and specifications, electric, natural gas, and telephone utility companies, interstate and intrastate natural gas pipeline companies, railroad companies, or authorities created pursuant to § 15.2-5102.

C. Erosion and Sediment Control (ESC) Plan" or "plan" - means a document containing material for the conservation of soil and water resources of a unit or group of units of land. It may include appropriate maps, an appropriate soil and water plan inventory and management information with needed interpretations, and a record of decisions contributing to conservation treatment. The plan shall contain all major conservation decisions and all information deemed necessary by the plan-approving authority to

assure that the entire unit or units of land will be so treated to achieve the conservation objectives.

D. MS4 – Means a city, town or village with land use control authority that is required to gain coverage under General Permit for Stormwater Discharges from Municipal Separate Stormwater Sewer Systems (MS4s).

E. Program administrator - means the person or persons responsible for administering and enforcing the VESCP or VSMP of a VESCP authority or a VSMP authority as may be applicable in the areas of ESC or stormwater management (SWM).

F. Certification - means the process whereby the board, on behalf of the Commonwealth, issues a certificate to persons who have completed board-approved training programs and met any additional eligibility requirements of 4VAC50-50-50 related to the specified classifications (4VAC50-50-40) within the areas of ESC or SWM or in other ways demonstrated adequate knowledge and experience in accordance with the eligibility requirements of 4VAC50-50-50 in the specified classifications within the areas of ESC or SWM.

G. Certified combined administrator for ESC - means an employee or agent of a VESCP authority who holds a certificate of competence from the board in the combined ESC classifications of program administrator, plan reviewer, and project inspector in the area of ESC. "Certified combined administrator for SWM" means an employee or agent of a VSMP authority who holds a certificate of competence from the board in the combined classifications of program administrator, plan reviewer, and project inspector in the area of SWM.

H. Project inspector - means anyone who, as a representative of a VESCP authority or a VSMP authority, is responsible for periodically examining the ESC or SWM activities and premises of a land-disturbing activity for compliance with the ESC Act and Regulations or the SWM Act and Regulations as may be applicable.

I. Certified plan reviewer for ESC - means an employee or agent of a VESCP authority who: (i) holds a certificate of competence from the board in the classification of plan reviewer in the area of ESC; (ii) is licensed as a professional engineer, architect, certified landscape architect, or land surveyor pursuant to Article 1 (§ 54.1-400 et seq.) of Chapter 4 of Title 54.1 of the Code of Virginia; or (iii) is a professional soil scientist as defined in Chapter 22 (§ 54.1-2200 et seq.) of Title 54.1 of the Code of Virginia.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. Virginia Erosion and Sediment Control Law
2. Virginia Erosion and Sediment Control Regulations and Certification Regulations
3. Virginia Erosion and Sediment Control Handbook

1.4 REGULATORY REQUIREMENTS

A. Comply with requirements of the erosion and sediment control plan as required by the Virginia Stormwater Management Permit (VSMP), and MS4 General Permit.

B. Comply with requirements and standards of local Municipality, County and local Soil and Water Conservation District.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Site Inspections:

1. Following the commencement of construction, site inspections shall be conducted by a Qualified Inspector at least once every seven (7) calendar days. If the project has been authorized to disturb greater than 5-acres of soil at any one time, the Qualified Inspector shall conduct at least two (2) site inspections every seven (7) calendar days. The two (2) site inspections must be separated by a minimum of two (2) full calendar days. During each inspection, the Qualified Inspector shall record the following information:

a. Inspect all sediment control practices and record the approximate degree of sediment accumulation as a percentage of the sediment storage volume (for example, 10 percent, 20 percent, and 50 percent).

b. Inspect all erosion and sediment control practices and record all maintenance requirements such as verifying the integrity of barrier or diversion systems (earthen berms or silt fencing) and containment systems (sediment basins and sediment traps). Identify any evidence of rill or gully erosion occurring on slopes and any loss of stabilizing vegetation or seeding/mulching. Document any excessive deposition of sediment or ponding water along barrier or diversion systems. Record the depth of sediment within containment structures, any erosion near outlet and overflow structures, and verify the ability of rock filters around perforated riser pipes to pass water.

c. All deficiencies that are identified with the implementation of the Erosion Control Plan.

2. The Contractor shall maintain a record of all inspection reports in a site log book. The site log book shall be maintained on site and be made available to the Engineer, MS4, and/or VESCP and other permitting authority upon request.

B. Stabilization: The Contractor shall initiate stabilization measures as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased. This requirement does not apply in the following instances:

1. Where the initiation of stabilization measures by the 14th day after construction activity temporarily or permanently ceased is precluded by snow cover or frozen ground conditions, stabilization measures shall be initiated as soon as practicable.

2. Where construction activity on a portion of the site is temporarily ceased, and earth-disturbing activities will be resumed within twenty-one (21) days, temporary stabilization measures need not be initiated on that portion of the site.

C. Maintenance: Sediment shall be removed from sediment trapping practices whenever their capacity has been reduced by fifty (50) percent from the design capacity.

D. Duty to Mitigate: The Contractor and its subcontractors shall take all reasonable steps to minimize or prevent erosion and sedimentation.

E. Proper Operation and Maintenance: The Contractor shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Contractor to minimize or prevent erosion and sedimentation.

1.6 COOPERATION

A. Examine drawings and specifications for other contracts, to determine nature of proposed construction. Perform work to conform to construction called for in such a manner as not to interfere or delay work of other Contractors.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise stated elsewhere in the contract documents, materials shall be as stated herein.

B. Mulch: Mulch shall be in conformance with NYSDOTSS §713-18 Hay, §713-19 Straw, or §713-11 Wood Fiber Mulch.

C. Temporary Seed: Seed shall be ryegrasses (annual or perennial) or cereal grasses suitable to the area and as a temporary cover which will not compete with the grasses sown later for permanent cover.

D. Stone Filling: Stone filling shall meet the requirements of NYSDOTSS §620-2.02 Stone Filling, light.

E. Geotextile: Geotextiles shall meet the requirements of NYSDOTSS §207-2 Materials. UV sensitive geotextiles shall be protected from exposure to sunlight during transport and storage.

F. Silt fence:

1. Posts: 1” galvanized steel channel post, “T” post or 1-1/4" nominal square hardwood stake of sound quality.
2. Fence: Minimum 14.5 gage, with maximum 6-inch mesh opening.
3. Geotextile Fabric: “Mirafi 100X” as manufactured by TC Mirafi, Pendergrass, GA 30567, 1-888-795-0808 or acceptable equivalent.

G. Prefabricated Siltfence: “Mirafi Envirofence” as manufactured by TC Mirafi, Pendergrass, GA 30567, 1-888-795-0808; “AEF Pre-assembled Silt Fence” as manufactured by American Engineering Fabrics, Inc., Bridgewater, MA, 02324, 1-800-770-2666 or acceptable equivalent.

H. Gravel Bag: Bags shall be fabricated from reinforced woven geotextile and shall include ties. No burlap bags shall be allowed. Coarse aggregate shall meet the gradation requirements of size designation #1 or #2 of NYSDOTSS Table 703-4 and shall be used as the fill material. Each gravel bag shall be individually tied and double bagged. The bag with fill material shall be inversely inserted into the second bag in order to prevent leakage.

I. Sand Bag: Sand bags shall meet the requirements of NYSDOTSS §209-2.09 Gravel Bag except that sand meeting the gradation requirements of NYSDOTSS §703-06 Cushion Sand shall be used as the fill material.

J. Rolled Erosion Control Products and Soil Stabilizers: These materials shall meet the requirements of NYSDOTSS §713-07 Jute Mesh or Other Approved Erosion Control Materials and shall be of the Type and Class specified in the contract documents.

K. Stabilized Construction Entrance: Construction entrances shall consist of a geotextile, crushed stone or gravel and, if necessary, a drainage pipe to maintain ditch flow

1. Geotextile: Geotextile shall meet the requirements of NYSDOTSS §207-2 Materials, Geotextile Stabilization, Strength Class 1.
2. Crushed Stone or Gravel: Crushed stone or gravel shall be 150 mm of coarse aggregate material meeting the gradation requirements of size designation #3 on NYSDOTSS Table 703-4.

3. Drainage Pipe: The Contractor shall provide a drainage pipe sized with sufficient capacity to carry ditch flow. The pipe dimension shall be consistent with the modified soil erosion and sediment control plan approved by the Engineer. The drainage pipe may consist of new or used material in satisfactory condition and suitable for the intended use. The Engineer will reject any materials determined to be unsatisfactory.

L. Temporary Pipe Inlet/Outlet Protection: The materials used shall be as indicated on the standard sheets.

PART 3 - EXECUTION

3.1 GENERAL

A. In the event of conflict between these specification requirements and pollution control laws, rules, regulations or permit conditions by other federal or state or local government agencies, the more restrictive laws, rules or regulations shall apply.

B. All work done under this section shall be performed consistent with VESCP and included as part of the construction schedule submitted by the Contractor under contract General and Supplemental provisions for start and progress of work. The Contractor's schedules and methods shall be consistent with the soil erosion and sediment control plan included in the contract documents or the modified plan approved by the Engineer. The Contractor shall begin earthwork only after receiving written approval from the Engineer for the scheduling of earthwork and work covered under this section.

C. The Contractor shall designate to the Engineer an erosion and sediment control supervisor who is a Trained Contractor with adequate experience and authority to implement and maintain all erosion and sediment control measures.

D. Perimeter sediment controls shall be installed prior to performing grubbing, excavation, and borrow or fill operations. The Contractor shall limit the area of clearing and grubbing, excavation, borrow and embankment operations in progress, commensurate with their capability and progress in keeping the finish grading, mulching, seeding and other temporary and/or permanent control measures current in accordance with the approved schedule. Under no condition shall earth material exposed by grubbing, excavation, borrow or fill or other work be left without application of temporary or permanent erosion controls for a period of greater than 7 days. The Engineer may determine that a potential for erosion or sediment transport exists and order the Contractor to install temporary erosion controls earlier. When permanent soil erosion and sediment control measures cannot be installed due to seasonal or other limitations, temporary soil erosion and sediment control measures shall be installed. Prior to removing or disturbing any erosion or sediment control measure that may be required to be reestablished due to continual grading operations, the Contractor shall verify the proposed progression of operations and the reestablishment of control measures with the Engineer to ensure the continuity of erosion and sediment control.

E. Sediment control measures shall not be removed without the Engineer’s approval.

F. No deviation from the specifications will be allowed without the written approval of the Owner’s Representative.

G. All earth berms and embankments are to be mulched and seeded within seven (7) calendar days after grading. All soil stockpiles are to be mulched and seeded within fourteen (14) calendar days after grading.

H. No slope shall be greater than 3.1 unless approved by the design engineer and stabilized with slope appropriate controls as directed by the engineer (erosion control blankets, etc.).

I. Stumps and brush may not be buried.

J. No deviation from the specifications will be allowed without the written approval of the Owner's Representative.

K. Installation of all erosion and sediment control practices to be in accordance with the current SWPPP and construction drawings (erosion and sediment control plans, notes, and details).

3.2 INSPECTION AND MAINTENANCE

A. Soil erosion and sediment control measures shall be inspected and maintained by the Contractor during the life of the project, including winter shutdown, etc. Such inspection and maintenance shall continue until after the permanent stabilization measures are in place and the temporary control measures are ordered to be removed by the Engineer. The remaining disturbed area shall be permanently stabilized as indicated in the contract documents.

B. All temporary controls shall be inspected by the Contractor at least every seven calendar days, after each rainfall of 1/2-inch (12 mm) or more within a 12 hour period, or daily during prolonged rainfall to determine if the measure is functioning as intended. All inspections shall be completed within one calendar day.

C. Within 3 calendar days from completion of the inspection, the Contractor shall:

1. Repair or rebuild the control measure to function as originally intended.
2. Remove sediment deposition which reaches one half the height of the control measure. All sediment deposits shall be considered unsuitable material and disposed of in accordance with Virginia Erosion and Sediment Control Regulations. Material shall be disposed of away from wetlands, water courses or other bodies of water.

D. Torn or punctured silt fence fabric may be repaired by the placement of a patch, on the upstream side, consisting of an additional layer of fabric over the damaged area, or replacement of the damaged section.

E. Where erosion control materials have been used on final grade that have been permanently seeded, the Contractor shall care for the areas until acceptance of the Contract or acceptance of the turf, whichever is later. Where necessary, such care may include, but is not limited to providing warning signs or barricades for protection against traffic. Any surfaces that have settled, become gullied, or otherwise damaged due to the Contractor's operations shall be repaired at no additional expense to the state to reestablish the grade and soil conditions that existed prior to placing erosion control materials.

3.3 TEMPORARY MULCH

A. The Contractor shall have the capability to mulch any disturbed areas on any given day (e.g., those areas where earthwork operations are ongoing, etc.). The Contractor shall apply mulch on disturbed areas consistent with the approved project schedule.

B. Mulch shall be spread uniformly in a continuous blanket at an approximate rate of 4 t/ha. Mulch may be spread by hand, mechanical spreaders, or blowers.

3.4 TEMPORARY SEED AND MULCH

A. The Contractor shall apply seed and mulch on disturbed areas consistent with the approved project schedule.

B. Prior to the application of seed, all areas where compaction has occurred shall be scarified. The seed bed shall be loose and friable for positive seed retention.

C. Ryegrasses shall be spread at a rate of 3.5 g/m2 to uniformly cover the ground. Cereal grasses shall be spread at a rate of 11.2 g/m2 to uniformly cover the ground. Seeds shall be evenly distributed by any method of sowing that does not injure the seeds in the process of spreading.

D. Mulch shall be spread immediately following application of seed. Mulch shall be spread uniformly in a continuous blanket at an approximate rate of 4 t/ha. Mulch may be spread by hand, mechanical spreaders, or blowers. Mulch and seed shall not be placed simultaneously, except in the case of hydroseeding.

3.5 TEMPORARY SILT FENCE

A. Unless otherwise detailed in the contract documents, silt fence shall be installed as follows:

1. Posts shall be driven into the ground.
2. Geotextile and any mesh support (if applicable) shall be placed on the upstream side of the posts.
3. The geotextile shall be fastened to each post in no less than 4 locations with approved fasteners.
4. The mesh support shall be fastened to each post at the top, bottom, and two additional evenly spaced locations, or by a continuous corded attachment along the top of the assembly.
5. Any geotextile or mesh splices necessary for fence erection shall be continuous between two post sections.
6. Geotextile at the bottom of the fence shall be buried in a trench to a depth of 150 mm. The trench shall be back filled with the excavated soil and the soil compacted by tamping.

3.6 DRAINAGE STRUCTURE INLET PROTECTION

A. Drainage structure inlet protection shall be placed where shown in the contract documents and constructed in accordance with the standard detail sheets.

B. Placing filter fabric beneath a drainage structure grate or wrapping a drainage structure grate in filter fabric is not an acceptable inlet protection practice.

3.7 ROLLED EROSION CONTROL PRODUCTS AND SOIL STABILIZERS

A. The time and method of placement shall be as specified in the contract documents and/or according to Manufacturer's recommendations. For areas at final grade, all loose stones, clods, sticks, or other undesirable material shall be removed in accordance with the manufacturer's recommendations or as specified elsewhere in the contract documents. In addition, those areas at final grade shall be scarified to a minimum depth of 25 mm immediately prior to installation, unless topsoil is being placed and the erosion control material will be installed within 2 workdays of topsoil placement.

B. Rolled Erosion Control Products:

1. Class II, Type A, Jute Mesh: Jute mesh shall be placed without stretching on the freshly prepared surface so that it lays loosely on the soil and in contact with the soil at all points; and then it shall be rolled or tamped firmly into the soil surface. The upper end of each roll shall be turned down and buried to a depth of 150 mm with the soil firmly tamped against it. Unless otherwise specified in the contract documents, check slots shall be constructed at 15 m intervals down the slope. The construction procedure shall consist of

placing a fold of material 150 mm vertically into the ground and tamping soil firmly against it. Jute mesh shall be placed so that all edges shall have a minimum overlap of 150 mm. The ends of rolls shall be placed with the upgrade section on top. Jute mesh shall be held tightly to the soil by anchors driven firmly into the ground. Anchors shall be spaced not more than 1 m apart on the sides and along the centerline of all drainage ways. Jute mesh ends and check slots shall have anchors spaced at 300 mm intervals.

2. Class I, Other Class II, and Class III Rolled Erosion Control Products: These products shall be placed and firmly anchored as stated in the manufacturer's instructions.

C. Class IV Soil Stabilizers: These materials shall be applied as recommended by the Manufacturer. Types A and B are intended to be applied with hydroseeding equipment. Type B may also be placed through dry spreading. When dry spreading method is used, the Contractor shall apply the material uniformly. Where applied, Type A shall be a minimum of 6 mm thick. When Type A is used in conjunction with turf establishment, seeds must be sown separately and prior to the application of the soil stabilizer.

3.8 CONSTRUCTION ENTRANCES

A. Construction entrances shall be placed where shown in the contract documents and constructed in accordance with the standard sheets.

B. The Contractor shall grade, including excavating or placing fill, to prepare the original ground surface for the placement of a stabilized pad of 150 mm of coarse aggregate material, underlain by a geotextile. If necessary, a drainage pipe shall be installed to maintain the capacity of the ditch. The pipe dimension shall be consistent with the modified soil erosion and sediment control plan approved by the Engineer. All areas cut or filled and not stabilized by the construction entrance material shall be covered with an erosion control treatment (temporary mulch, temporary seed and mulch, etc.) and shall be included in this pay item.

C. When washing is performed, the washing area within the construction entrance shall be located in an area which will drain into an approved sediment control measure(s).

D. The construction entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto the right-of-way. All sediment spilled, dropped, washed or tracked onto the right-of-way shall be removed immediately. In the event the entrance is no longer performing properly (i.e. the entrance aggregate becomes clogged with sediment), the Contractor shall top-dress the entrance with additional coarse aggregate material.

3.9 TEMPORARY PIPE INLET/OUTLET PROTECTION, SILT FENCE

A. Temporary pipe inlet/outlet protection, silt fence, shall be placed where shown in the contract documents and constructed in accordance with the standard detail sheets.

END OF SECTION

SECTION 31 3116

TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Description of Work: Work of this section includes, but is not limited to, the following:
   1. Soil treatment for termite control.

1.2 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's treatments and application instructions, including EPA-Registered Label.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: Submit certificates signed by manufacturers of termite control products certifying that treatments furnished comply with requirements.

B. Qualification Data: Submit applicator qualifications verifying years of experience; include list of completed projects having similar scope of work identified by name, location, date, reference names and phone numbers.

1.4 CLOSEOUT SUBMITTALS

A. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following as applicable:
   1. Date and time of application.
   2. Moisture content of soil before application.
   3. Brand name and manufacturer of termiticide.
   4. Quantity of undiluted termiticide used.
   5. Dilutions, methods, volumes, and rates of application used.
   6. Areas of application.
   7. Water source for application.

B. Warranty: Submit signed and dated warranty.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A pest control operator (PCO) who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment similar to that indicated for this Project and whose work has a record of successful in-service performance.

B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with U.S. Environmental Protection Agency (EPA) regulations and authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Environmental Limitations:
1. To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring.
2. Comply with EPA-Registered Label requirements and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction.

1.7 WARRANTY

A. Provide five year written warranty signed by applicator and Contractor, warranting that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide:
1. Provide EPA-registered termiticide complying with requirements of authorities having jurisdiction, in soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation.
2. Use only soil treatment solutions that are not harmful to plants.
3. Provide quantity required for application at label volume and rate for maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

B. Acceptable manufacturers: Provide products from one of the following.
1. AgrEvo Environmental Health, Inc.; a Company of Hoechst and Schering, Berlin.
2. American Cyanamid Co.; Agricultural Products Group; Specialty Products Department.
3. Bayer Corp.; Garden & Professional Care.
4. FMC Corp.; Pest Control Specialties.
5. Zeneca Professional Products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation

work, landscaping, and other conditions affecting performance of termite control. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General:
   1. Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate.
   2. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.

B. Soil Treatment Preparation:
   1. Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated.
   2. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings.
   3. Termiticides may be applied before placing compacted fill under slabs if recommended by termiticide manufacturer.

C. Fit filling hose connected to water source at site with backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION

A. General: Comply with most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

B. Application:
   1. Mix soil treatment termiticide solution to uniform consistency.
   2. Provide quantity required for application at label volume and rate for maximum specified concentration of termiticide, according to manufacturer=s EPA-Registered Label, to following so that continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute the treatment evenly.
      a. Slabs-on-grade: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
      b. Foundations: Adjacent soil including soil along entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers, piers, and chimney bases; and along entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
      c. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
      d. Masonry: Treat voids.
      e. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

C. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

D. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supports slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

E. Post warning signs in areas of application.

F. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping or other construction activities following application.

G. Clean up area in accordance with EPA and other applicable governing regulations.

END OF SECTION

SECTION 31 5000

EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
2. Division 31 Section "Dewatering" for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

A. Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

B. Safety:

1. The Contractor is responsible for job site safety.
2. The Contractor shall comply with all applicable safety rules and regulations of OSHA, VOSHA and other agencies having jurisdiction over the Work.
3. All safety measures related to, but not necessarily limited to, trenching, confined space, traffic control and other applicable safety measures, shall be strictly adhered to and enforced by the Contractor.

1.4 PROJECT CONDITIONS

A. Protection of Existing Utilities:

1. It shall be the responsibility of the Contractor to conduct the Work in such a manner as to avoid damage to, or interference with, any utility services.
2. If such damage, interference, or interruption of service occurs as a result of his work, it shall be the Contractor’s responsibility to promptly notify the Owner and utility owner of the occurrence and to repair or caused to be repaired the damage immediately, at his own expense, and to the satisfaction of the Owner and the owner of the utility.

3. Further, it shall be the Contractor's responsibility to uncover and expose the location of all service connections to avoid damage or interruption of service. If damage occurs, the Contractor shall make the necessary repairs in accordance with the above requirements.
4. It is also the responsibility of the Contractor to determine in advance of beginning his construction effort the exact location of all utilities, and the effect they will have on his work by contacting "Miss Utility" 48 hours prior to starting work, telephone 1.800.552.7001 for assistance.

B. Protection of Persons and Property:

1. Barricades for open excavations or work area shall be provided. All such barricades shall be in accordance with the requirements of the authorities or agencies having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by work or other operations in the area.
3. Equipment used for this Work shall meet all local, State and Federal safety standards and any other applicable standards governing this Work. All power machinery shall have adequate mufflers to keep noise to a minimum. The Contractor is responsible for complying with the requirements of the Town's noise ordinance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

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 that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32 1216

ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes all equipment, labor, material, and services required for complete installation of guard rail, aggregate base courses and asphalt concrete pavement structures and specialties for municipal street systems.

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. Virginia Department of Transportation: VDOT.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

B. Shop Drawings:

1. Guard Rail.
2. Plan Indicating pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Samples: For each paving fabric, 12 by 12 inches minimum.

D. Qualification Data: For qualified manufacturer.

E. Material Certificates: For each paving material, from manufacturer.

F. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by VDOT.

B. Testing Agency Qualifications: Qualified according to the latest VDOT Road and Bridge Specifications for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of VDOT for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 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 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 subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 degrees F.
2. Tack Coat: Minimum surface temperature of 60 degrees F.
3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
4. Asphalt Base Course: Minimum surface temperature of 40 degrees F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 degrees F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees F for oil-based materials, and not exceeding 95 degrees F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Aggregate Base: Shall be Type I, size 21A or 21B, graded aggregate base material, as defined in VDOT Road and Bridge Specifications, Section 208, "Subbase and Aggregate Base Material."

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, AASHTO MP 1a, PG 64-22, or as recommended by local paving authorities to suit Project conditions.

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material or as recommended by local paving authorities to suit Project conditions.

C. Prime Coat: Cut-back asphalt RC-250, meeting requirements of AASHTO M81.

D. Prime Coat: Cover aggregate shall be VDOT No. 68 stone.

E. Tack Coat: Emulsified asphalt CRS-1 meeting requirements of VDOT Section 210.

F. Seal coat shall be cationic emulsion asphalt CRS-1 or CRS-2, meeting requirements of AASHTO M208 or cut-back asphalt RC-250, meeting requirements of AASHTO M81 .

G. Seal coat cover aggregate shall be VDOT No. 78 stone.

H. Water: Potable.

2.3 GUARD RAIL

A. Products shall conform to Section 221, Guardrail, of the Virginia Department of Transportation, Road and Bridge Specifications, latest revision and the Virginia Department of Transportation, Road and Bridge Standards, 2001 or latest revision.

2.4 PAVEMENT MARKINGS

A. Pavement markings shall be in accordance with VDOT Road and Bridge Specifications Section 246.

1. Stop bars and turning arrows shall be reflective thermoplastic markings
2. Roadway lines shall be reflective paint
3. Parking stall lines and crosswalk lines shall non-reflective paint
4. Handicap pavement markings shall be blue paint equivalent to roadway marking paint

B. Markings shall be resistant to deformation by traffic.

PART 3 - EXECUTION

3.1 EXAMINAITION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Subgrade Preparation: Subgrade preparation shall consist of the final machining of the subgrade immediately prior to placing the aggregate base course. The surface shall be true to line and grade. Construction methods and equipment shall conform to applicable portions of Section 305 "Subgrade and Shoulders," of VDOT Road and Bridge specifications.

C. Aggregate base course construction methods and equipment shall conform to requirements of Section 309, "Aggregate Base Course," of VDOT Road and Bridge specifications.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 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.

B. Prime Coat: Apply prime coat at rate of 0.20 to 0.50 gallon per square yard over compacted aggregate base in accordance with VDOT Road and Bridge specifications, Section 311, "Prime Coat."

C. Tack Coat: Apply tack coat to contact surfaces of previously constructed asphalt or hydraulic cement concrete and surfaces abutting or projecting into asphalt concrete pavement. Apply at rate of 0.05 to 0.15 gallon per square yard of surface in accordance with VDOT Road and Bridge specifications, Section 310, "Tack Coat."

3.5 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd..

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.6 HOT-MIX ASPHALT PLACING

A. Asphalt concrete base course shall be VDOT BM-25.0 meeting requirements of VDOT Road and Bridge specifications, Section 211.

B. Asphalt concrete surface course shall be VDOT SM-9.5A meeting requirements of VDOT Road and Bridge specifications, Section 211.

3.7 INSTALLATION TOLERANCES

A. Pavement 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. Pavement 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.

3.8 GUARDRAIL

Execution shall conform to Section 505, Guardrail and Steel Median Barriers, of the Virginia Department of Transportation, Road and Bridge Specifications, latest revision and the Virginia Department of Transportation, Road and Bridge Standards, 2008 or latest revision.

3.9 PAVEMENT MARKING

A. Pavement Markings shall be installed in accordance to VDOT Road and Bridge Specifications Section 704.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

3.11 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION

SECTION 32 1313

CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes Concrete Paving. Including the Following:
   1. Driveways.
   2. Sidewalks
   3. Utility Pads

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

D. Tie Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

G. Zinc Repair Material: ASTM A 780/A 780M.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I/II .
2. Fly Ash: ASTM C 618, Class C or Class F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: Potable and complying with ASTM C 94/C 94M.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1-1/2 percent for 1-1/2-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range, water-reducing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 4,500 psi.
2. Maximum W/C Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated on drawings. Joint spacing should not exceed 24 times the concrete thickness or a 2:1 aspect ratio. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete within 6 hours of concrete placement, when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

D. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.11 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 1443

POROUS UNIT PAVING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of the Permeable Articulating Concrete Block/Mats (P-ACB/M) in accordance with the fines, grades, design and dimensions shown on the Contract Drawings and as specified herein.

B. SUBMITTAL

The contractor shall submit to the engineer all manufacturer's performance research results and calculations in support of the permeable articulating concrete block/mat (P-ACBM) system and geosynthetic proposed for use.

The contractor shall furnish manufacturer's certificates of compliance for the permeable articulating concrete blocks/mats, revetment cable, and any revetment cable fittings and connectors to the engineer prior to the start of mat fabrication.

The contractor shall furnish to the engineer all manufacturer's specifications, literature, shop drawings for the fabrication of the mats, and recommendations, if applicable, that are specifically related to this project, 14 days prior to assembly of the permeable articulating concrete block/mats.

PART 2 - PRODUCTS

2.1 GENERAL

A. Permeable articulating concrete block/mats shall be premanufactured of individual concrete blocks with specific stormwater runoff capacities, bound into mats by the use of revetment cables. The mats shall arrive at the jobsite assembled according to lengths and widths as specified on the shop drawings.

Individual blocks in the articulating concrete mats shall be staggered, beveled, and interlocked for enhanced stability. The mats shall be constructed of closed cell blocks with an arched storage chamber for additional stormwater storage as shown on the contract drawings. Parallel strands of cable shall extend through two (2) ducts in each block in a manner which provides for longitudinal binding of the blocks within the mats. Each row of blocks shall be laterally offset by one-half block width from the adjacent row so that any given block is cabled to four other blocks (two in the row above and two in the row below). Six adjacent blocks shall also surround each block.

Each block shall incorporate interlocking surfaces that prevent lateral displacement of the blocks within the mats when they are lifted by the longitudinal revetment cables. The interlocking surfaces must not protrude beyond the perimeter of the blocks to such an extent that they reduce the flexibility or articulating capability of the articulating concrete mats or become damaged or broken when the mats are lifted during shipment or placement. Once the mats are in place, the interlocking surfaces shall prevent the lateral displacement of the blocks even if the cables should become damaged or removed. The mats must be able to flex a minimum of 10 degrees between any given row and column of blocks in the uplift direction.

The cables shall be inserted into the mats in such a manner to form lifting loops at one end of the mat with the corresponding cable ends spliced together to form a lifting loop at the other end of the mat with sleeves approved by the engineer.

Infiltration Performance: The P-ACB/M will only be accepted when accompanied by documented third party surface infiltration performance characteristics based on ASTM C1701/C1701M-09. The surface infiltration rate shall be no less than 4,000 inches per hour on an outdoor working surface, with typical base material utilized for the test.

Structural Performance: The design of the P-ACB/M shall be capable of supporting AASHTO HS-20 and H-20 truck loading. The blocks should be analyzed as unreinforced concrete arches supporting a uniform truck tire load with impact per AASHTO standards. *As with all vehicular traffic paving systems, the subgrade soil, geosynthetic and base preparation for the P-ACB/M must be properly designed and prepared. This is critical to the performance of the system.*

B. Cellular Concrete Blocks

1. Materials
   a. Cementitious Materials – Materials shall conform to the following applicable ASTM specifications:
   b. Portland Cements - Specification C 150, for Portland Cement.
   c. Blended Cements - Specification C 595, for Blended Hydraulic Cements.
   d. Hydrated Lime Types - Specification C 207, for Hydrated Lime Types.
   e. Pozzolans - Specifications C 618, for Fly Ash and Raw or Calcinated Natural Pozzolans for use in Portland Cement Concrete.
   f. Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:
   g. Normal Weight - Specification C 33, for Concrete Aggregates.

2. Physical Requirements
   a. At the time of delivery to the work site, the units shall conform to the physical requirements of ASTM D 6684-04 as prescribed below.

TABLE 1. PHYSICAL CHARACTERISTICS

Compressive Strength (average of 3 units)
- Min. psi = 4,000, mpa = 27.6

Water Absorption (average of 3 units)
- Max. lb/ft^3 = 10, kg/m^3 = 160

3. Visual Inspection
   a. All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

   b. Cracks exceeding 0.25 inches in width and/or 1.0 inch in depth shall be deemed grounds for rejection.

   c. Blocks rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. Blocks rejected at the job site shall be replaced at the expense of the contractor.

4. Sampling and Testing

   a. The purchaser or his authorized representative shall be accorded proper access to the manufacturer to inspect and sample the permeable concrete blocks at the place of manufacture from lots ready for delivery.

5. Expense of Tests

   a. Additional testing, other than that provided by the manufacturer, shall be borne by the purchaser.

6. Manufacturer
   a. The permeable articulating concrete block mat shall be PaveDrain® or pre-approved equal, as represented by:

<u>NATIONALLY</u>
PaveDrain, LLC
PMB 292 – 7245 S. 76th St.
Franklin, WI 53132-9041
PH. (414) 423-6531
info@pavedrain.com
www.pavedrain.com

The PaveDrainR permeable articulating concrete mats shall have the following nominal characteristics as identified on the plans.

TABLE 2. STANDARD SIZES AND WEIGHTS OF *PaveDrain*[R] PERMEABLE ARTICULATING CONCRETE BLOCK/MATS

CLASS	E BLOCK WEIGHT TYPE	BLOCK SIZE (in.) CHAMBER Lbs./Sq.Ft.	STORAG Length	Width	Height	Volume (in.)
S6-45	Closed	42-48	11.9	12.00	5.65	1.0

C. Revetment Cable and Fittings

Polyester Revetment Cable and fittings. Revetment cable shall be constructed of high tenacity, low elongating, continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The weight of the parallel core shall be between 65% to 70% of the total weight of the cable. The revetment cable shall have the following physical characteristics listed below.

Nominal Cable Diam.	- Circum.	Approx. Ave. Strength Lbs.	Weight/100 ft. Min. lbs.	Max Lbs.
1/4"	- 20mm	3,700	2.47	2.74
5/16"	- 27mm	7,000	3.99	4.42
3/8"	- 30mm	10,000	4.75	5.26
1/2"	- 40mm	15,000	8.93	9.90

NOTE: Polyester cable shall be determined by the supplier, based on the size of the mats to be placed.

Elongation requirements specified below are based upon stabilized new, dry, cable. Stabilization refers to a process in which the cable is cycled fifty (50) times between a load corresponding to $200D^2$ and a load equal to 10%, 20%, or 30% of the cables approximate average breaking strength. Relevant elongation values are as shown in the table below. The tolerance on the values is + 5%.

	% Breaking Strength 10%	20%	30%
Permanent Elongation (while working)	0.7	1.8	2.6
Elastic Elongation	0.6	1.4	2.2
Total Stretch	1.3	3.2	4.8

The revetment cable shall exhibit good to excellent resistance to most concentrated acids, alkalis, and solvents. Cable shall be impervious to rot, mildew and degradation. The materials used in the construction of the cable shall not be affected by continuous immersion in stormwater runoff.

Selection of cable and fittings shall be made in a manner that insures a safe design factor

for mats being lifted form both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 60% of the minimum rated cable strength. Fittings such as sleeves and stops shall be aluminum and washers shall be galvanized steel unless otherwise shown on the Contract Drawings.

D. Size of Permeable Articulating Concrete Block/Mats

If the permeable articulating concrete blocks/mats cables and fittings are fabricated at the manufacturer or another approved location into mats with a width of up to eight (8) feet and a length of up to thirty-six (36) feet or approved by the Engineer.

PART 3 - FOUNDATION PREPARATION AND MAT INSTALLATION

A. Foundation and Preparation

General. Areas on which permeable articulating concrete block/mats are to be placed shall be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents, and approved by the Engineer.

Grading. The aggregate bedding layer shall be graded to a smooth plane surface to ensure intimate contact is achieved between the legs of the permeable articulating concrete block/mats and the aggregate bedding layer. A small plate compactor is recommended.

Inspection. Immediately prior to placing the permeable articulating concrete block/ mats the prepared area shall be inspected by the Engineer, the owner's representative, and or by the manufacturer's representative. No blocks/mats shall be placed thereon until that area has been approved by one of these parties.

B. Placement of Permeable Articulating Concrete Blocks/Mats

General. Permeable articulating concrete block/mats, shall be constructed within the specified lines and grades shown on the contract drawings.

Placement. The permeable articulating concrete block/mats shall be placed on the aggregate bedding layer so as to produce a smooth plane surface. No individual block within the plane of placed articulating concrete mats shall protrude more than one-quarter inch of an inch or as otherwise specified by the Engineer.

If installed in mats the permeable articulating concrete block/mats shall be attached to a spreader bar or other conventional device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The equipment used should be adequate capacity to place the mats without bumping, dragging, or otherwise damaging the aggregate bedding layer. The mats shall be “zippered” together forming a seamless mat to mat connection.

Consultation. The manufacturer or representative of the permeable articulating concrete

blocks/mats shall provide design and construction advice during the design and installation phases of the project.

FINISHING. The joints between the P-ACB/M do not require backfilling with smaller aggregates or sand in order to function properly. The joints are meant to be left open.

END OF SECTION

SECTION 32 3113

CHAIN LINK FENCES AND GATES

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. Chain-link fences.
2. Gates: horizontal slide, swing.

B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete post footings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence and gate posts, rails, and fittings.
2. Chain-link fabric, reinforcements, and attachments.
3. Gates and hardware.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Samples for Verification: Prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified factory-authorized service representative.

B. Product Certificates: For each type of chain-link fence, and gate, from manufacturer.

C. Product Test Reports: For framing strength according to ASTM F 1043.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:

1. Polymer finishes.
2. Gate hardware.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding. Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Preinstallation Conference: Conduct conference at Project site.
1. Review coordination of interlocked equipment specified in this Section and elsewhere.
2. Review required testing, inspecting, and certifying procedures.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. Base Bid: General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm).

   a. Mesh Size: 2 inches (50 mm).
   b. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft. (122 g/sq. m).
   c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F 1183, with mill finish, and wire diameter of 0.148 inch (3.76 mm).

   a. Mesh Size: 2 inches (50 mm).

4. Selvage: Knuckled at both selvages.

B. Add Alternate #4: General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm).

   a. Mesh Size: 1/2 inches (13 mm).
   b. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft. (122 g/sq. m).
   c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F 1183, with mill finish, and wire diameter of 0.148 inch (3.76 mm).

   a. Mesh Size: 1/2 inches (13 mm).

4. Selvage: Knuckled at both selvages.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, 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: 1.9 inches (48 mm) in diameter.
   b. End, Corner and Pull Post: 2.375 inches (60 mm) in diameter.

3. Horizontal Framework Members: top and bottom rails complying with ASTM F 1043.

   a. Top Rail: 1.66 inches (42 mm) in diameter.

4. Metallic Coating for Steel Framing:

   a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
   b. Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
   c. External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
   d. Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
   e. Coatings: Any coating above.

2.3 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:

   1. Type I, aluminum coated (aluminized).

B. Aluminum Wire: 0.192-inch- (4.88-mm-) diameter tension wire, mill finished, complying with ASTM B 211 (ASTM B211M), Alloy 6061-T94 with 50,000-psi (344-MPa) minimum tensile strength.

2.4 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.

   1. Gate Leaf Width: As indicated.
   2. Gate Fabric Height: As indicated.

B. Pipe and Tubing:

   1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; manufacturer's standard protective coating and finish.
   2. Gate Posts: Round tubular steel.
   3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Hardware:

1. Hinges: 180-degree outward swing.
2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Closer: Manufacturer's standard.

2.5 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

a. Hot-Dip Galvanized Steel: 0.106-inch- (2.69-mm-) diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

H. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.

2. Aluminum: Mill finish.

2.6 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable 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.

2.7 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Aluminum.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed 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 for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

D. Line Posts: Space line posts uniformly at 96 inches (2440 mm) o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. 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:

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Intermediate and Bottom Rails: Install and secure to posts with fittings.

I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch (25.4 mm) between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 GATE OPERATOR INSTALLATION

A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation for Support Posts, Pedestals, and Equipment Bases/Pads: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate-operator component manufacturer's written instructions and as indicated.

C. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.7 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:

1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.9 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.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION

SECTION 323119

DECORATIVE METAL FENCES AND GATES

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. Decorative aluminum fences.
2. Swing Gates.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete post concrete fill.

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. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches (300 mm) in length for linear materials.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 8-foot length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE ALUMINUM FENCES

A. Decorative Aluminum Fences: Fences made from aluminum extrusions.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

B. Posts: Square extruded tubes.

1. Line Posts: 2-1/2 by 2-1/2 inches (64 by 64 mm) with 0.100-inch (2.54-mm) wall thickness.
2. End and Corner Posts: 2-1/2 by 2-1/2 inches (64 by 64 mm) with 0.100-inch (2.54-mm) wall thickness.

C. Post Caps: Aluminum castings that cover entire top of posts.

D. Rails: Extruded-aluminum channels, 1-7/16 by 1-1/4 inches, with 0.100-inch- (2.54-mm-) thick sidewalls and 0.070-inch- (1.78-mm-) thick top.

E. Pickets: Extruded-aluminum tubes, 3/4 inch (19 mm) square, with 0.050-inch (1.27-mm) wall thickness.

1. Terminate tops of pickets at top rail for flush top appearance.
2. Picket Spacing: 3 15/16 inches clear, maximum.

F. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components.

G. Fabrication: Assemble fences into sections by fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

2.3 SWING GATES

A. Gate Configuration: Double leaf.

B. Gate Frame Height: 72 inches (1830 mm).

C. Gate Opening Width: As indicated.

D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes 2-1/2 by 2-1/2 inches (64 by 64 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication. Sizes to be determined by manufacturer.

E. Additional Rails: Provide as indicated, complying with requirements for fence rails.

F. Infill: Comply with requirements for adjacent fence.

G. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

1. Treillage: Provide iron castings of pattern indicated between each pair of pickets. Finish as specified for gates.

H. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

I. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

J. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- (19-mm-) diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

K. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

L. Metallic-Coated-Steel Finish: Galvanized finish.

2.4 Aluminum Finish: Baked enamel or powder coating

2.5 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

C. Tubing: ASTM B 429/B 429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.

F. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.7 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Aluminum.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.

2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches (16 by 2440 mm).

2.8 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils (0.05 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range (Black, Semi-gloss).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails to posts. Peen threads of bolts after assembly to prevent removal.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed 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 and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches (51 mm) above grade. Finish and slope top surface to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.

4. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch (20 mm) larger than outside diagonal dimension of post.

    a. Extend posts at least 36 inches into concrete.
    b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
5. Space posts uniformly at 95” o.c.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:

    1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).

        a. Gates and Other Fence Openings: Ground fence on each side of opening.

            1) Bond metal gates to gate posts.
            2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 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.

END OF SECTION 323119

SECTION 32 3223

SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The following are minimum requirements and shall govern, except that local, state and/or federal codes and ordinances shall govern when their requirements are in excess hereof.

C. Division 01, Sustainable Design Requirements Section 01811313 for credits MR 4 and MR 5.

1. The above listed LEED credits are related to this section. Other LEED credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.2 SUMMARY

A. This Section includes single-depth segmental retaining walls with and without soil reinforcement.

B. Related Sections include the following:

1. Section 033000 "Cast-in-Place Concrete" for segmental retaining wall footings.
2. Section 312000 "Earth Moving" for excavation for segmental retaining

1.3 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.

D. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.

E. Drainage: Provide segmental retaining wall drainage system capable of preventing accumulation of groundwater in retained soils and in retaining wall foundation soils.

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For concrete units.

C. Samples for Verification: For each color and texture of concrete unit required. Submit sections of units not less than 3 inches (75 mm) square.

D. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer and testing agency.

B. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.

1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for segmental retaining wall units and soil reinforcement.

1. Include test data for freeze-thaw durability of segmental retaining wall units.
2. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
3. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

D. Research/Evaluation Reports: For segmental retaining wall units and soil reinforcement.

E. Source quality-control reports.

F. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall approximately 72 inches (1800 mm) long by not less than 36 inches (900 mm) high above finished grade at front of wall.

a. Include typical soil reinforcement.
b. Include typical base and cap or finished top construction.
c. Include backfill to typical finished grades at both sides of wall.
d. Include typical end construction at one end of mockup.
e. Include 36-inch (900-mm) return at 1 end of mockup, with typical corner construction.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Pre-Installation Conference: Conduct conference at Project site.

1. Review methods and procedures related to segmental retaining walls including, but not limited to, the following:

a. Structural load limitations.
b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Field quality-control procedures.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to moisture, temperature changes, contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store on elevated platforms, protected from moisture, sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

1.9 COOPERATION

A. Examine drawings and specifications for other Contracts, to determine nature of proposed construction. Perform work to conform to construction called for in such a manner as not to interfere or delay work of other Contractors.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch (1.6 mm) from specified dimension.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, licensees of one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by a licensee of one of the following:
   a. Rockwood Retaining Walls, Inc.
   b. Allan Block Corporation.
   c. Anchor Wall Systems, Inc
   d. Keystone Retaining Wall Systems, Inc.; a Contech company.
   e. Tensar Earth Technologies, Inc.
   f. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.
3. Provide units that comply with requirements for freeze-thaw durability.
4. Provide units that interlock with courses above and below by means of integral lugs or lips, pins or clips.

B. Color: As selected by Architect from manufacturer's full range.

C. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

D. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.

E. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

2.2 INSTALLATION MATERIALS

A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from non-degrading polymer reinforced with glass fibers.

B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from non-degrading polymer reinforced with glass fibers.

C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

D. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base material.

E. Drainage Fill: Comply with requirements in Section 334600 "Subdrainage".

F. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 (4.75-mm) sieve, 0 to 60 percent passing No. 40 (0.425-mm) sieve, 0 to 35 percent passing No. 200 (0.075-mm) sieve, and with fine fraction having a plasticity index of less than 20.

G. Non-reinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

H. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).

I. Subdrainage Pipe and Filter Fabric: Comply with requirements in Section 334600 "Subdrainage."

J. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:

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. Colbond Inc.
b. Huesker, Inc.
c. Luckenhaus Technical Textiles, Inc.
d. Mirafi Construction Products; Ten Cate Nicolon.
e. Propex Fabrics Inc.; Civil Engineering Fabrics.
f. Strata Systems, Inc.
g. Synteen Technical Fabrics, Inc.
h. Tenax Corporation; Subsidiary of Tenax Group.
i. Tensar Earth Technologies, Inc.
j. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.
k. Webtec, Inc.

2. Product Type: Molded geogrid made from high-density polyethylene.

2.3 SOURCE QUALITY CONTROL

A. Direct manufacturer to test and inspect each roll of soil reinforcement at factory for minimum average roll values for geosynthetic index property tests including the following:

1. Weight.
2. Roll size.
3. Grab or single-rib strength.
4. Aperture opening.
5. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions. Lay units in running bond.

1. Lay units in running bond.
2. Form corners and ends by using special units.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

C. Leveling Course: Place un-reinforced lean concrete over base course to thickness indicated; compact and screed to a smooth, level surface.

D. First Course: Place first course of segmental retaining wall units on leveling base/course for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.
2. Place and compact fill, either drainage or soil fill as indicated, to top of first course. Place fill on both sides of wall at same time without disturbing alignment of units. Fill voids between and within units with drainage fill.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with pins, install pins and align units according to manufacturer's written instructions.
4. For units with clips, install clips and align units according to manufacturer's written instructions.
5. Fill voids between and within units with drainage fill.

F. Cap Units: Place cap units and secure with cap adhesive according to manufacturer's written instructions.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving" NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

   a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
   b. In areas where fill height exceeds 15 feet (4.5 m,) compact reinforced-soil fill that will be more than 15 feet (4.5 m) below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.
3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches (300 mm) wide behind drainage geotextile to within 12 inches (300 mm) of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place a layer of drainage fill at least 12 inches (300 mm) wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.

G. Place impervious fill over top edge of drainage fill layer.

H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.

I. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches (200 mm) into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches (150 mm) of fill over reinforcement before compacting with tracked vehicles or 4 inches (100 mm) before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet (32 mm in 3 m), 3 inches (75 mm) maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet (32 mm in 3 m).

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet (32 mm in 3 m).

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 150 feet (45 m) or less of segmental retaining wall length.

3.6 ADJUSTING AND CLEANING

A. Remove and replace segmental retaining wall construction of the following description:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if methods and results are approved by Architect.
2. Segmental retaining walls that do not match approved Samples and mockups.
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION

SECTION 32 9200

TURF AND GRASSES

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. Seeding.
2. Hydroseeding.
3. Turf renovation.
4. Erosion-control material(s).

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
2. Section 334600 "Subdrainage" for below-grade drainage of landscaped areas.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawncare Manager.
    c. Landscape Industry Certified Lawncare Technician.

5. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: April 1st to June 15th.
2. Fall Planting: September 15th to November 1st..

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Mixtures:

1. Type 1 - For General Lawn Areas:

	Proportion By Weight	Min. Purity	Min. Germination	Lbs./ 1,000 sq. ft.
a. Eclipse, Baron, Abbey or Bristol KY Bluegrass:	25%	90%	85%	1.5
b. Palmer III, Manhattan 3 or Achiever Perennial Ryegrass:	30%	95%	85%	1.8
c. Jamestown II, or Treasure Chewings Fescue:	20%	90%	85%	1.2
d. Rebel II or Aztec Tall Fescue:	25%	95%	85%	1.5
Total:				6.0

2. Type 3 - Banked Roadsides (all slopes 4' horizontal to 1' vertical or greater)

		Proportion By Weight	Min. Purity	Min. Germination	Lbs./ 1,000 sq. ft.
a.	Jamestown II, or Treasure Chewings Fescue:	15%	95%	85%	0.9
b.	Palmer III, Manhattan 3 or Pennant II Perennial Ryegrass:	10%	95%	90%	0.6
c.	Rebel II or Aztec Tall Fescue:	40%	95%	85%	2.4
d.	Reliant II Hard Fescue	20%	95%	85%	1.2
e.	Salty Alkali grass	15%	90%	85%	0.9
	Total:				6.0

3. Type 6 - For Erosion Control Areas

		Proportion By Weight	Min. Purity	Min. Germination	Lbs./ 1,000 sq. ft.
a.	Palmer III, Manhattan 3 or Pennant II Perennial Ryegrass	15%	95%	85%	0.9
b.	Rebel II or Aztec Tall Fescue:	45%	95%	85%	2.7
c.	Reliant II Hard Fescue	20%	95%	85%	1.2
d.	Tall Wheatgrass	20%	90%	85%	1.2
	Total:				6.0

C. Seed Species:

1. Quality: State-certified seed of grass species as listed below for solar exposure.
2. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
3. 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).

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 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 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

E. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch (75-mm) nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement.

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m).

C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions per Erosion and Sediment Control Plans.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches

(38 mm) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

F. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 TURF RENOVATION

A. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

H. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.

I. Apply seed and protect with straw mulch as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

3.8 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.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Water with fine spray at a minimum rate of 1/2 inch (13 mm) per week for six weeks after planting unless rainfall precipitation is adequate

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow to a height of 1-1/2 to 2 inches (38 to 50 mm).

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

3.9 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).

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.12 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.

    a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION

SECTION 32 9300

PLANTS

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. Plants.
2. Tree stabilization.
3. Tree-watering devices.

B. Related Requirements:
1. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag.

Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. 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.

I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. 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.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. 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.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Trees and Shrubs: Samples of each variety and size delivered to site for review. Maintain approved Samples on-site as a standard for comparison.
2. Compost Mulch: 1-pint (0.5-L) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
3. Mineral Mulch: 2 lb (1.0 kg) of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.
4. Weed Control Barrier: 12 by 12 inches (300 by 300 mm).
5. Proprietary Root-Ball-Stabilization Device: One unit.
6. Slow-Release, Tree-Watering Device: One unit of each size required.
7. Root Barrier: Width of panel by 12 inches (300 mm).

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Interior.
    c. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15th to May 20th.
2. Fall Planting: October 1st to December 1st.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 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.
   c. Faulty performance of tree stabilization.
   d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.

   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:

   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

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.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing

trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 5-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch (25-mm) sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.4 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.

2.5 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 8 inches (200 mm) in diameter and 48 inches (1200 mm) long, treated with specified wood pressure-preservative treatment.
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.
4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.

2.7 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

B. Root Barrier: Black, molded, modular panels 18 inches (457 mm) high (deep), 85 mils (2.2 mm) thick, and with vertical root deflecting ribs protruding 3/4 inch (19 mm) out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.

C. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

D. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.3 PLANTING AREA ESTABLISHMENT

A. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom

raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Backfill: Planting soil for trees, use excavated soil for backfill.]
2. 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. 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.

4. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Balled and Potted and Container-Grown Stock: 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. Carefully remove root ball from container without damaging root ball or plant.
3. 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.

4. 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.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet (4.2 m) in height and more than 3 inches (75 mm) in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

a. Securely attach guys to stakes 30 inches (760 mm) long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.
b. For trees more than 6 inches (150 mm) in caliper, anchor guys to wood deadmen buried at least 36 inches (900 mm) below grade. Provide turnbuckle for each guy wire and tighten securely.

c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.

d. Attach flags to each guy wire, 30 inches (760 mm) above finish grade.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

C. Root-Ball Stabilization: Install at or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.

1. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches (150 mm) 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 mulch ring of 2-inch (50-mm) average thickness, with 12-inch (300-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.10 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than **25** percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 6 inches (150 mm) or smaller in caliper size.
2. Species of Replacement Trees: Same species being replaced.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.15 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: 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: **12** months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: 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: Six months from date of Substantial Completion.

END OF SECTION

DIVISION 33

UTILITIES

SECTION 33 0510

TELEVISION INSPECTION OF SEWER LINES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes all the equipment, labor, and materials necessary to perform all work for television inspection of sewer lines.

1.2 SUBMITTALS

A. Submit a written description of procedures to be used to the Owner, including product literature for all digital video equipment including, but not limited to cabling, camera, monitor, footage counter, digital video titling device, and recorder.

B. Submit a written/printed copy of television inspection logs to the Owner. Logs shall record defects according to NASSCO's Pipeline Assessment and Certification Program (PACP) or/and Manhole Assessment and Certification Program (MACP).

C. Submit 2 copies of visual and audio recording to the Owner. The Owner will review the inspections, not for accuracy of content, but to make sure that the required information is provided and the recording is of acceptable quality. If the Owner determines that the recording is defective or not of adequate quality, the Contractor shall TV inspect again at the Contractor's expense.

1.3 QUALITY ASSURANCE

A. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

B. The Contractor shall comply with the latest revision of the Virginia Occupational Safety and Health Standards for the Construction Industry as adopted by the Safety and Health Codes Commission of Virginia.

C. The Contractor shall comply with Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, "Virginia Erosion and Sedimentation Control Handbook," latest revision.

D. The sewer line cleaning shall remove foreign materials from the lines and restore the sewer to a minimum of 95 percent of the original carrying capacity or as required for proper seating of an internal pipe liner. It is recognized that there are some conditions such as broken pipe and major blockages that prevent cleaning from being accomplished or where additional damage would result if cleaning were attempted or continued. Should such conditions be encountered, the contractor will not be required to clean those specific sections. If in the course of normal

cleaning operations, damage does result from pre-existing and unforeseen conditions such as broken pipe, the contractor will not be held responsible.

E. The television inspection shall be performed one section of line at a time.

F. Inspection shall be performed in accordance with NASSCO's Pipeline Assessment and Certification Program (PACP) or/and Manhole Assessment and Certification Program (MACP).

1.4 COORDINATION

A. The contractor shall completely remove and dispose of all dirt, debris, rubbish and surplus, and unsuitable materials at the end of each work day at no additional cost to the owner.

B. Whenever the contractor desires to use a hydrant for water supply, the contractor shall obtain the permission of the owner. All costs associated with the use of water supplied from hydrants shall not be paid for separately but shall be deemed to be included in the bid. Operation of hydrant shall be in accordance with the City Of Lynchburg Backflow Prevention Program. Use of an RPZ device or air gap is required.

PART 2 - PRODUCTS

2.1 SEWERLINE CLEANING

A. All high-velocity sewer cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two or more high-velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 to 45 degrees in all size lines designated to be cleaned. Equipment shall also include a high-velocity gun for washing and scouring manhole walls and floor. The gun shall be capable of producing flows from a fine spray to a solid stream. The equipment shall carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel.

2.2 DIGITAL VIDEO SYSTEM

A. The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100 percent humidity conditions. The camera, television monitor, and other components of the digital video system shall be capable of producing picture quality to the satisfaction of the engineer; and if unsatisfactory, equipment shall be removed and no payment will be made for an unsatisfactory inspection.

B. Recordings of all sewer line inspections shall be made on DVD. The audio portion of the composite digital video shall be sufficiently free from electrical interference and background noise to provide complete intelligibility of the oral report.

C. A footage counter device, which measures the distance traveled by the camera in the sewer, shall be accurate to plus or minus 2 feet in 1,000 feet.

D. Digital video equipment shall include genlocking capabilities to the extent that computer generated data (i.e., footage, date, size, address and location, etc.) as determined by the Owner can be overlaid onto digital video, and both indicated on the television monitor and permanently recorded on the digital inspection.

PART 3 - EXECUTION

3.1 SEWER LINE CLEANING

A. Sewer line shall be cleaned prior to Television Inspection

B. During sewer cleaning operations, satisfactory precautions shall be taken in the use of cleaning equipment to insure that the water pressure created does not damage or cause flooding of property or buildings being served by the sewer.

C. The designated sewer sections shall be cleaned using high-velocity jet equipment. The equipment shall be capable of removing dirt, grease, rocks, sand, and other materials and obstructions from the sewer lines and manholes. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning again attempted. If, again, successful cleaning cannot be performed or the equipment fails to traverse the entire section, it will be assumed that a major blockage exists and the cleaning effort shall be abandoned.

D. Roots shall be removed in the sections where root intrusion is a problem. Special attention should be used during the cleaning operation to assure almost complete removal of roots from the joints. Roots which could prevent installation of a pipe liner shall be removed. Procedures may include the use of mechanical equipment such as rodding machines, bucket machines, and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners.

E. Sludge, dirt, sand, rocks, grease, and other solid or semisolid material resulting from the cleaning operation shall be captured and removed at the downstream manhole of the section being cleaned, loaded in a suitable container, transported to the nearest wastewater treatment facility, and disposed of at that facility in accordance with all requirements and charges.

F. Water used to clean the sewer lines shall be discharged into the sanitary sewer downstream of the cleaning operation. Under no circumstances shall the contractor discharge water used to clean sewer lines onto the ground or into streams.

G. Acceptance of sewer line cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the engineer. If television inspection shows the cleaning to be unsatisfactory, the contractor shall be required to re-clean and re-inspect the sewer line until the cleaning is shown to be satisfactory.

3.2 TELEVISION INSPECTION OF SEWER LINE

A. Move the camera through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. In no case pull television camera at a speed greater than 30 feet per minute. Use manual winches, power winches, TV

cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions to move the camera through the sewer line.

B. If, during the inspection operation, the television camera will not pass through the entire section, set up equipment so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire section, the obstruction shall be cleared by cleaning, root removal, or point repair as directed by the City Engineer or Project Engineer and the section reinspected.

C. When manually operated winches are used to pull the television camera through the line, set up telephones or other suitable means of communication between the two manholes of the section being inspected to insure good communications between members of the crew.

D. Measurement for location of defects shall be aboveground by means of a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Check accuracy of the distance meter by use of a walking meter, roll-a-tape, or other suitable device. The accuracy shall be satisfactory to the City Engineer and the Project Engineer.

E. The camera image shall be down the center axis of the pipe when the camera is in motion. The Contractor is required to provide a 360-dregree radial view of the pipe interior using a camera with pan and tilt capabilities for 8-inch diameter and larger pipes. Points of interest shall also be digitally recorded and shall include, but not be limited to, defective joints, ovality, debris, sediment, cracked pipes, holes, or blockages.

3.3 DOCUMENTATION OF THE TELEVISION RESULTS

A. Television Inspection Logs: Develop and keep printed location records that clearly show the location in relation to an adjacent manhole of each infiltration point observed during inspection. In addition, record other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, broken pipe, presence of scale and corrosion, and other discernible features.

B. Photographs: Take digital photographs or digital video stills of any defects or points of interest recorded on the inspection report. If no defects are present provide one still image of pipe for information purposes.

C. Videotape Recordings: A visual and audio recording of all areas of the lines shall be performed and produced in a format that may be replayed in a standard CD/DVD player/recorder device.

END OF SECTION

SECTION 33 1000

WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies water system piping with associated valves, hydrants, fittings, anchors, air vents, and other allied equipment or material.

1. System Description: Work in this Section specifies all potable water system work outside of buildings.
2. The project site is with in the 864 pressure zone. Working pressure outside of the building is around 63 psi

B. Related Sections:

1. Section 311000 “Site Clearing.”
2. Section 312000 “Earth Moving.”
3. Section 312319 “Dewatering.”

1.2 Reference specifications are referred to by abbreviation as follows:

A. American Association of State Highway and Transportation Officials.....AASHTO

B. American National Standards Institute.....ANSI

C. American Society for Testing and Materials.....ASTM

D. American Water Works Association.....AWWA

E. Commercial Standard (National Bureau of Standards).....CS

F. National Sanitation Foundation.....NSF

1.3 SUBMITTALS

A. Provide the following in a timely manner in accordance with the approved submittals schedule as specified in Division 1 - General Requirements.

1. Shop drawings of the following:

a. Pipe and Fittings
b. Valves and accessories
c. Water meters and accessories

d. Double Detector check valves
e. Fire Hydrants.
f. Fire Hydrant Connections

2. Bacteriological test reports.

1.4 Quality Assurance

A. Products Criteria:

1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
2. Manufacturer's name, or identifiable trademark, securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Comply with the rules and regulations of the City of Lynchburg over the connection to public water lines and the extension, and/or modifications to City of Lynchburg systems.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain first paragraph below for ABS, PVC, or fiberglass piping.

B. Pipe Condition/Pipe Examination
1. New Pipe Inspection: Inspect materials thoroughly upon arrival. Examine materials for damage. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications. Check bells and spigots closely for smoothness, roundness, and honeycombing (concrete pipe), which may be a source of infiltration. Check for cracks, chips, etc. on both ends. Reject any pipe that will not provide watertight seal or is otherwise structurally deficient.

2. Pre-Installation Inspection: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipe damaged or deemed not to conform to these specifications shall be rejected and removed from site. All pipe in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells must be true.

C. Observe manufacturer's directions for delivery and storage of materials and accessories.

D. Protect pipe coating during handling using methods recommended by the manufacturer. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

E. Prevent damage to pipe during transit. Protect stored piping from entry of water or dirt into pipe. Also, protect bells and flanges of special fittings from entry of moisture and dirt.

F. Support pipe to prevent sagging or bending.

G. Use slings to handle valves and fire hydrants if size requires handling by crane or other type of lift. Do not use handwheels or stems to lift or for rigging points.

H. Store fire hydrants and valves in such a way as to prevent entry of water and dirt into openings. Support off the ground or pavement. If fire hydrants or valves are provided with end protectors, do not remove until ready for installation or for inspection. Once inspected, replace protectors. Protect valves against damage to threaded ends or flanges.

1.6 PROJECT CONDITIONS:

Separation of water lines and sanitary and/or combined sewers.

A. Follow Virginia Department of Health Waterworks Regulations for separation of water mains and sewer lines.

B. Parallel Installation:

1. Normal Conditions - Water lines shall be constructed at least 10 feet horizontally from a sewer or sewer manhole whenever possible, the distance shall be measured edge-to-edge.
2. Unusual Conditions - When local conditions prevent a horizontal separation of at least 10 feet, the water line may be laid closer to a sewer or sewer manhole provided that:

   a. The bottom of the water line is at least 18 inches above the top of the sewer.
   b. Where this vertical separation cannot be obtained, the sewer shall be constructed of ductile iron pipe as specified in paragraph 2.1 of this section and pipe pressure-tested in place to 50 psi without leakage prior to backfilling. The sewer manhole shall be of watertight construction and tested in place.

C. Crossing:

1. Normal Conditions - Water lines crossing over sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water line and the top of the sewer whenever possible.
2. Unusual Conditions - When local conditions prevent a vertical separation described in crossing, normal conditions, paragraph above, the following construction shall be used.

   a. Sewers passing over or under water lines shall be constructed of the materials described in parallel installation, unusual conditions - paragraph 2 above.
   b. Water lines passing under sewers shall, in addition, be protected by providing:

      1) A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line,
      2) Adequate structural support for the sewers to prevent excessive deflection of the joints and settling on and breaking water line,
      3) That the length of the water line be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer.

D. Sanitary and/or combined sewers or sewer manholes - No water pipes shall pass through or come in contact with any part of a sewer or sewer manhole.

1.7 COORDINATION

A. The City of Lynchburg will be the sole operator of all valves and hydrants on the City water system.

B. Contact Department of Water Resources to coordinate interruption of services and/or operation of valves. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of the Water Resources (Utilities) Engineer, temporary service may be required to be provided. Provide a minimum of 48 hours notice of the proposed utility interruption or necessary operation of valves.

C. Coordinate tie-in to municipal water mains with the City of Lynchburg Water Resources (Utilities) Engineer.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe

Ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA C151/ ANSI A21.51 for 4-inch and larger diameter pipe, Class 50, minimum (See Design Section). The thickness of Ductile Iron Pipe shall be determined by considering trench load and internal pressure (the pressure zone and variances in which the pipe will be used) separately in accordance with AWWA C150/ANSI A21.50. Pipe shall be of the class indicated on the drawings.

The ductile iron pipe shall be cement mortar lined with a seal coat in accordance with AWWA C104/ANSI 21.4. Outside coat shall be a minimum of 1-mil bituminous paint according to AWWA C151/ANSI A21.51 Section 51-8.1.

Ductile Iron Pipe shall be as manufactured by the American Cast Iron Pipe Company, United States Pipe and Foundry Company, Griffin Pipe Products Company, or McWane Cast Iron Pipe Company.

B. Copper pipe

Copper pipe shall be Type K Soft Copper Tube, meeting ASTM B88 Standard Specification for Seamless Copper Water Tube. Copper pipe shall be used on sizes 3/4 inch through 2-inch.

2.2 PIPE JOINTS AND FITTINGS

A. Push-on Joint, Ductile Iron Pipe shall conform to AWWA C151/ANSI A21.51 (such as "Fastite," "Tyton," or "Bell-Tite."). The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, and comply with AWWA C111/ANSI A21.11.

B. Mechanical Joint, Ductile Iron Pipe shall be used only at the specific locations indicated on the drawings or as approved by the engineer.

1. The mechanical joint shall consist of:
   a. A bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting;
   b. A pipe or fitting spigot;
   c. A sealing gasket;
   d. Separate ductile iron follower gland having cored or drilled bolt holes; and
   e. Ductile iron tee head bolts and hexagon nuts.
2. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe or fitting while maintaining a leak proof joint connection. The mechanical joint shall conform to the requirements of Federal Specification WW-P-421, AWWA C111/ANSI A21.11, and ASTM A 536 Standard Specification of Ductile Iron Castings.

C. Restrained Joint shall be TR Flex as manufactured by U. S. Pipe and Foundry Company, Flex Ring as manufactured by American Ductile Iron Pipe Company, Snap Lok as manufactured by Griffin Pipe Products Company, or approved equal.

D. Fittings shall be ductile iron and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSI 21.53 for compact fittings, pipe sizes 3 inches through 48 inches. All ductile iron fittings shall have a minimum working pressure rating of 350 psi and shall be cement mortar lined and bituminous coated in accordance with AWWA C104/ANSI A 21.4. The fittings shall be tested and the manufacturer shall provide certified test result when requested by the City of Lynchburg. This testing shall include hydrostatic proof testing of fittings. Glands, gaskets, and bolts shall conform to AWWA C111/ANSI A 21.11. The use of push-on fittings is not permitted. Restrained joints shall be Megalug series 1100 mechanical joint restraint by EBAA Iron Sales, Inc. or approved equal. See Standard Detail 26.04, sheet 2 of 2 for figure of Megalug.

2.3 VALVES AND HYDRANTS

A. GATE VALVES, RESILIENT WEDGE (4 INCHES AND LARGER)

All gate valves shall be of the resilient wedge type complying with AWWA C509 and shall be UL listed and FM approved for a working pressure of 200 psi. All internal parts shall be

accessible without removing the body from the line. The wedge shall be of cast iron completely encapsulated with resilient material. The resilient sealing material shall be permanently bonded to the cast iron wedge with a rubber tearing bond to meet ASTM D429 Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates and AWWA C550.

Non-Rising Stems (NRS) stems shall be cast bronze with integral collars in compliance with AWWA. Outside Screw and Yoke (OS&Y) stems shall be bronze. The NRS stuffing box shall have two "O"-Ring seals above the thrust collar. These rings shall be field replaceable without removing the valve from service.

Each valve shall be hydrostatically tested at 400 PSI to the requirements of both AWWA and UL/FM.

All gate valves shall be of the mechanical joint type.

Valves shall open counter-clockwise (left) and shall be equipped with a 2-inch square AWWA operating nut.

B. Gate Valve sizes 4 inches through 18 inches shall be as manufactured by American Flow Control, Clow, Mueller, or Kennedy. Approved Models are listed below:

Model	**Manufacturer**
2500 NRS	American Flow Control
Resilient Wedge Valve	Clow
A-2360-20	Mueller
Kenseal II	Kennedy

2.4 Tapping Sleves and Valves: The tapping sleeve and valve shall be suitable for wet installation without interruption of water service.

A. Tapping Sleeves: The sleeve shall be all stainless steel construction and have a full circumference gasket for a watertight seal. The sleeve shall have a minimum working pressure of 250 psig. The sleeve shall be equipped with a test plug to allow for pressure testing of the seal prior to tapping. Tapping sleeves shall meet the requirements of AWWA C223 and be manufactured by Romac Industries, Smith-Blair, or Ford Meter Box Co.

B. Tapping Valves: Tapping valves shall meet the requirements of Gate Valves as specified above in Part 2- PRODUCTS, Gate Valves, paragraph 2.2.1 except that the seat openings shall be larger than nominal size and valve ends shall be mechanical joint.

Tapping valves shall be "O" ring type with mechanical joint and conforming to AWWA non-rising stem construction. Inlet flange end shall be Class 125 (ANSI B16.1).

Approved tapping valves are listed below:

Model	Manufacturer
2500 NRS	American Flow Control
F-5093	Clow
T-2360	Mueller
Kenseal II	Kennedy

2.5 FIRE HYDRANTS

A. See standard detail 26.09. Fire hydrants shall comply with AWWA C502, latest revision, UL 246 and FM1510. Approved fire hydrants including model and manufacturer are listed below:

		Pressure Zone	
Model	**Manufacturer**	**Standard**	**High Pressure**
B-84-B	American Flow Control	X	X
Medallion	Clow	X	X
Super Centurion	Mueller	X	X
Guardian	Kennedy	X	X

Interior coating to be in accordance with AWWA C550. Minimum working pressure shall be 150 psi except use 250 working pressure in high-pressure zones. Nozzles shall have National Standard threads. Hydrants shall consist of the following:

1. Two 2½ -inch fire nozzles and one 4½ -inch pumper connection.

2. All nozzles shall be provided with caps with the cap retaining chains removed.
3. The hydrant valve opening shall be 5¼ inches.
4. Bronze to bronze threads shall be provided between the hydrant seat or seat ring and the seating attaching assembly.
5. All hydrants must include cast or ductile epoxy lined shoe, rubber drain seals and positive protective valve stop device.
6. Hydrants shall open left and shall have a 6-inch mechanical joint elbow.
7. The hydrant barrel shall be of sufficient length to provide a minimum bury of 3 feet.
8. Hydrants shall be of the compression type closing with line pressure and shall be of the traffic model breakaway type.
9. Hydrant cap and stuffing box shall be of unitized, one-piece design creating a watertight cavity without the use of gaskets. The combination of O-Rings to a crimped brass ferrule around the stem shall seal the cavity from contact with water. Hydrant caps shall have a means for providing periodic lubrication of the operating threads.
10. The operating nut shall be of one-piece bronze construction. A thrust washer shall be supplied between the operating nut and stem lock nut.
11. The main valve shall be of synthetic rubber reinforced with steel. The seat shall be of a bronze ring threaded to a bronze insert in the hydrant shoe, with O-Rings to seal the drain way and barrel from leakage of water in the shoe.
12. The hydrant drain hole shall momentarily force flush with each operation.
13. Hydrant is to be painted color and type of paint as specified by the City's Water Resources Department. Contact the Department of Water Resources for information. Fire Hydrants with a working pressure greater than 100 psi shall have the 2½ -inch connection caps painted black gloss.
14. If line is to be pressurized within 7 days, then 3000 psi high early strength concrete shall be used.

2.6 CORPORATION STOPS, ANGLE VALVES, AND CURB STOPS

A. Corporation stops, angle valves, and curb stops shall be ball-type as manufactured by Ford, Mueller, or A. Y. McDonald.

2.7 FLEXIBLE COUPLINGS

A. Flexible couplings shall be of a gasketed, sleeve type. Each coupling shall consist of a steel middle ring, two steel followers, two rubber compounded wedge section gaskets and sufficient galvanized track head steel bolts to properly compress the gaskets. Couplings shall be of the type to match piping on which installed. Couplings shall be Smith-Blair Type 441, Ford FC-1 (2" through 12"), Ford FC-2A (14" through 24"), or Romac 501.

2.8 MISCELLANEOUS CONCRETE

A. Concrete Classes (VDOT) to Design Compressive Strength at 28 days (f'c):

Class A4.5	General	4,500 psi
Class A4	General	4,000 psi

Class A3	General	3,000 psi
Class B2	Massive or Lightly Reinforced	2,200 psi

Ready mixed concrete shall comply with ASTM C94, Standard Specification for Ready-Mixed Concrete. All exposed concrete shall be air entrained. Concrete strength shall be as specified on standard details and drawings. Unless otherwise specified, all concrete shall be Class A3, minimum.

2.9 PIPE SADDLE SUPPORT – ADJUSTABLE

Pipe saddle supports shall equal or exceed the Standon Model S92, as manufactured by Material Resources, Inc., Hillsboro, OR. or approved equal.

2.10 SERVICES

Services greater than 2”, water service pipe shall be ductile iron pipe and fittings. All taps shall use appropriate size tapping slave and valve.

2.11 METERS

A. Water meter shall be Turbo Meter per AWWA C701. Meter shall be Recordall II and shall be RTR Badger with Orion Pit Transmitters with data profile and 20-foot wire lead. All meters shall read in cubic feet.

2.12 TIE-RODS

A. Tie rods shall be ASTM A307 Steel, cadmium coated and of size and number as shown on Standard Detail 26.03. No duck lugs shall be allowed.

2.13 VAULT ACCESS HATCH

A. The aluminum access frames and covers are provided with a 1/4-inch thick structural grade aluminum channel frame with the flanges acting as a continuous concrete anchor. The inside of the frame has a continuous door support angle that must be cast into the top slab of the vault. Door leaves shall be a minimum of 1/4-inch thick aluminum diamond plate with structural grade aluminum. Door lifting aids of aluminum tubular construction with compression springs to assist in opening and closing of the doors. The doors are provided with heavy-duty stainless steel hinges with tamper-proof fasteners. All hardware is to be stainless steel. The doors open to 90 degrees and lock automatically in that position with a stainless steel positive locking arm and a stainless steel release handle. Doors are provided with a stainless steel lifting handle, stainless steel snap-lock with removable key handle. Two key handles shall be provided with each door. The door leaves extend to the outside perimeter of the frame for added support.

The aluminum access frames and covers shall carry a 10-year guarantee against defects in materials and workmanship. The frame and cover shall equal or exceed the units manufactured by Halliday Products, Inc., The Bilco Company, or an approved equal.

PART 3 - EXECUTION

3.1 PIPE LAYING

A. Ductile Iron Pipe

Water mains and fittings shall be installed with approved tools in accordance with the requirements of AWWA Standard Specification C-600, Installation of Ductile Iron Water Mains and Their Appurtenances, which is made a part of this specification by reference.

Construct piping to accurate lines and grades avoiding localized high points and support as required on drawings or described in specifications.

No more than 500 feet of trench is to be open at any time.

Due care shall be taken in the storing and handling of pipes, fittings and valves to avoid contamination with the ground and prevent foreign matter from entering pipe and fittings.

Pipe, fittings, and valves shall be carefully handled and lowered into the trench. Under no circumstances shall any pipe or fitting be dumped or rolled into the trench, or be allowed to drop against the pipe or fitting already in the trench. Great care shall be taken to prevent the pipe lining and coating from being damaged, and the Contractor shall not install any damaged pipe. The contractor shall be responsible for removal and disposal of damaged pipe.

The Contractor shall be required at the end of the day's work to keep the end of the line, under construction, plugged to prevent foreign matter from entering pipe and fittings.

Special care shall be taken to insure that the pipe is well bedded on a solid foundation, and any defects due to settlement shall be made good by the Contractor at his own expense. Bell holes shall be dug sufficiently large to insure the making of proper joints. Special precautions shall be exercised to prevent any pipe from resting on rock. A minimum of 6 inches is required between rock and the bottom of pipe.

Whenever a pipe requires cutting, to fit in the line or to bring it to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools which will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe or liner. When the cut end is to be assembled in a bell, an adequately smooth (without sharp edges) bevel should be ground or filed on the cut edge to prevent damage to or dislodgement of the gasket during assembly. The methods of cutting pipe shall be in accordance with Manufacturer's recommendations. No welding, flame cutting or flame tapping will be allowed. Such cuts shall be made by the Contractor without extra compensation.

Mains shall be installed to the depth as indicated on the plans, but in no case with a cover of less than 36 inches below finished grade for mains 8 inches and smaller and 48 inches below finished grade for mains 10 inches and larger, as shown on Standard Detail 26.01. In the event site conditions prevent adherence to minimum cover requirements, approval of an alternate cover depth by City Engineer is required.

Maximum horizontal deflections for ductile iron pipe shall meet AWWA C600, latest revision.

B. Installing Mechanical Joint Pipe

1. Clean socket and plain end thoroughly, removing mud, oil, gravel, or any other foreign matter. Gaskets shall be lubricated. Paint the bell and the spigot with soap solution (half cup granulated soap dissolved in 1 gallon of water). Slip ductile iron gland on spigot end with the lip extension of the gland toward the end of the pipe. Paint rubber gasket with or dip into the soap solution and place on the spigot end with thick edge toward the gland.

2. Push the spigot end forward to seat in the bell. Then, press the gasket into the bell so that it is located evenly around the joint. Move the gland into position, insert bolts, and screw nuts up finger tight. Then tight all nuts to torque listed below (excerpted from Table 2 of AWWA C600-99):

Bolt Size (Inches)	Torque (Ft. – Lbs)
5/8	45 – 60
¾	75 – 90
1	100 – 120
1 1/4	120 - 150

Tighten nuts on alternate side of the gland until pressure on the gland is equally distributed.

3. Restrained joint pipe shall be installed per Manufacturer's recommendations.

C. Installing Push-On Pipe

Clean the socket and 8 inches of the outside of the plain end thoroughly, removing mud, gravel, or any other matter that might cause the front of the gasket to protrude into the path of the entering spigot. Gaskets shall be lubricated. Flex rubber gasket and apply lubricant supplied with the pipe to the plain end and to the inside surface of the gasket before assembly. Insert gasket fully in the gasket recess of the socket, large end of the gasket entering first.

For assurance of proper gasket positioning, a thin automotive, blade-type feeler gauge can be used for quick and easy probing to confirm a properly installed gasket position around the joint. Start the spigot end of the pipe in to the socket with care. The circumferential stripe on the plain end provides a visual indication for checking the proper insertion of the joint. Homing of the joint shall be done with a forked tool or jack-type device.

Restrained joint pipe shall be installed per Manufacturer's recommendations.

3.2 Connections to Existing Main

The Contractor shall furnish all materials for connection to existing water mains where shown on the plans.

In making connections to the existing distribution system, valves shall be set as shown on the plans

Request for operations of valves shall be made to the Department of Water Resources 48 hours in advance of operation of valve needs. Before shutting off any main, residents are to be notified by a City representative in writing at least 24 hours in advance of cut off.

The City of Lynchburg Department of Water Resources shall be the sole operator of all valves and fire hydrants.

If the connection to the existing mains requires a wet tap, such tap shall be done by a firm experienced and equipped to do this type of work. All materials and labor shall be provided by the contractor to include, but not necessary limited to the sleeve, valve, tapping machine, accessories, installation, and testing of such materials to complete the work. The Water Resources (Utilities) Engineer shall have the right to accept or reject the firm or crew performing the work.

All connections to existing mains shall follow the Department of Water Resources, Standard Operating Procedure for Utility Line Maintenance, SOP-ULM-02-B, 'Preventing Contamination of Water Supply During Water Main Construction and Repair Made by Contractor'.

Work shall be scheduled at least 5 working days in advance and a crewman from the Department of Water Resources shall be present during the operation.

3.3 ABANDONMENT OF AN EXISTING WATER LINE

When an existing water line is replaced with a new water line, abandonment of the existing line is required once it is no longer in service. The line shall be abandoned at its source/main by cutting and removing a one-foot segment of the line. When abandoning mains 4-inch and less in diameter, the line shall be cut at the corporation stop on the main or as close to the main as possible and a one-foot segment of the line removed. In either situation, if a water control device is not located at the source, plugging of the branch at the source will be required. Location of abandonment shall be approved by the City's representative. All water control devices to be abandoned shall be closed and valve boxes removed to 6 inches below the surface.

3.4 VALVES AND FIRE HYDRANTS

A. Gate Valves

1. Setting of Valves: Valves shall be installed with stems in a vertical plane through the pipe axis and perpendicular to the pipe axis. The contractor shall clean the valves before installation and check for satisfactory operation. All valves adjacent to tees or bends shall be tied to the fitting with ASTM A307 threaded cadmium coated tie rods (see Standard Detail 26.03 for number and diameter of tie rods required). Valve nut extensions shall not be installed unless approved by the City of Lynchburg Engineer.

2. Valves without gearing or operators shall be installed with a 2-piece valve box with lid (see Standard Detail 26.16). Valve boxes shall be set in alignment with the valve stem centered on the valve nut. Boxes shall be set in a manner to prevent transmitting shock or stress to the valve with stone around pipe and under valve box. Valve box cover must be set flush with the finished ground surface or pavement. The contractor shall be responsible for keeping valve boxes clean and free of any foreign matter until acceptance of the project.

3. All valve boxes located outside the pavement shall be set to grade and a precast reinforced concrete shoulder slab shall be installed. See Standard Detail 26.18.

4. All valve box covers shall be painted with 2 coats of blue paint.

B. TAPPING SLEEVES AND VALVES

1. A tapping sleeve and valve shall be installed in accordance with the manufacturer's recommendations or as directed by the City Engineer at locations as shown on plans. After installation of the tapping sleeve and valve and prior to performing the tap, the assembly shall be hydrostatically tested at a pressure equal to the test pressure of the new line installed. Such pressure shall be maintained with no loss for a minimum time of 15 minutes.

C. FIRE HYDRANTS

1. Fire hydrant locations shall be as shown on the plans or as otherwise directed by the City Engineer. Hydrants shall be set upon VDOT #57 stone in such manner as to preclude the possibility of settlement of hydrants. Place ½ cubic yard loose VDOT #57 stone around the hydrant elbow and wrap in non-woven filter fabric. See Standard Detail 26.09.
2. Hydrants are to be located at a distance from the curb or edge of pavement to provide ready access and minimize the possibility of damage from vehicles and set to the height prescribed by Standard Detail 26.09 with the pumper nozzle facing or pointing to the street or fire access lane. Hydrants must be set with the stem vertical/plumb and the flange above grade. Traffic model fire hydrants are to be installed such that the breakaway flange is not less than 2 inches or more than 6 inches above finished grade. The Contractor is responsible for determining barrel length and ordering to meet conditions. Where adjustments in height are needed, extension kits shall be provided and installed. Extensions shall be no more than 1 foot per hydrant. Where hydrants are set behind guardrails, the pumper nozzle shall be set with its centerline a minimum of 12 inches above the top of the guardrail.
3. Install fire hydrant pad around all hydrants as shown on Standard Detail 26.09.
4. Operation and Painting: Hydrants, upon installation and prior to acceptance of the project, shall be painted and greased, and individually operated in the presence of the City of Lynchburg Construction Coordinator to verify the hydrant is wet.
5. Place a black plastic bag or an “Out of Service” ring around steamer nozzle of newly installed fire hydrant until hydrant is placed in service and accepted by the City of Lynchburg.
6. Install hydrant valve as close to the main as possible.
7. End of Line Hydrants are to be restrained by mechanical joints. Where hydrant branches are of considerable length, the City Engineer may require the rods to be attached to the valve and the valve to a thrust block behind the first full joint of pipe on the hydrant branch beyond the hydrant leg valve. If rodded, the hydrants are to be rodded to the valve and the valve to the main with ¾ inch ASTM A307 diameter threaded rods as per Standard Detail 26.08 Provide a minimum of two ¾ inch diameter rods for lines with static pressures up to 100 psi. For lines with greater than 100-psi static pressure, use four ¾ inch diameter rods. All rods are to be cadmium coated. Any rods, which have been cut, are to be coated liberally with hot asphalt or other acceptable rust inhibitor to protect

steel from corrosion. If mechanical joint restraints are utilized, the system shall be designed as specified on the Standard Detail 26.08.

3.5 Services

A. All services shall be pressure tested in conjunction with main.

B. All service taps on the main greater than that allowed by pipe manufacturer for a direct tap shall have a saddle type corporation. All 2-inch taps on 6-inch or 8-inch mains shall require installation of a saddle. Corporation stop for direct taps may be used on ductile iron pipe and shall have AWWA Standard tapered threads. See Standard Detail 26.12.

C. The contractor shall set 2-inch and larger meters. Meters smaller than 2 inches will be provided by the City of Lynchburg.

D. All meters 3 inches and larger shall be installed in a vault provided by the developer as per Standard Details 26.19 through 26.21. Transmitter housings shall be mounted in the aluminum vault hatch flush with the exterior surface.

E. Vault Construction shall be in accordance with Standard Details 26.19 and 26.20.

3.6 CONCRETE ANCHOR BLOCKS

A. Concrete anchor blocks shall be constructed in accordance with Standard Detail 26.02. Concrete anchors may be unformed but minimum dimensions must be maintained. All fittings and pipe shall be wrapped in plastic prior to installation of concrete. Concrete anchors shall bear against undisturbed earth.

3.7 TESTING AND DISINFECTION

A. Prerequisites Conditions for Testing and Disinfection shall be as follows:

1. All pipe has been laid and the trench backfilled.

2. Hydrants shall be properly located, operable and plumb and at correct elevation.

3. Valves shall be properly located, operable and at correct elevation. Valve boxes or manholes shall be centered over operating nuts and the top of the box or manhole shall be at proper elevation.

4. All services shall be installed.

5. All reaction anchors have had sufficient set of 7 days or high early strength concrete, 3000 psi or greater, may be used to reduce the number of days required.

6. Lines shall be properly vented where entrapped air is a consideration.

7. All visible leaks, broken or cracked pipe, valves, hydrants, etc. shall be repaired.

8. Air release valves shall be installed complete and in place.

9. All construction activities on the project, that requires trenching or excavation within the limits of the water location shall be completed.

3.8 ORDER OF OPERATIONS

A. After all prerequisites are met, fill the system with water at a velocity of approximately 1 foot per second while necessary measures are taken to eliminate all air. After filling, shut off system in order to prevent chlorinated water from flowing back in the line supplying the water.

B. Allow filled system to set undisturbed for a minimum of 24 hours, then begin flushing operations. Contractor shall utilize an RPZ device on the flushing hydrant/blowoff. Flushing shall be a velocity of not less than 2.5 feet per second. The contractor shall be responsible for making adequate provisions for drainage of flushing water, at his expense. Any damages that may occur from this operation shall be the sole responsibility of the contractor. In conjunction with start of flushing operation, the City's Construction Coordinator will perform a high range chlorine concentration test. Chlorine concentration of 50 mg/l minimum must be provided. See paragraph 3.10 Disinfection and Bacteriological Testing.

C. After allowing the system to flush until the chlorine concentration is less than 1 mg/l or no higher than that generally prevailing in the source system, the first bacteria sample shall be collected at regular intervals not exceeding 2000 feet and tested for bacteriological quality. See paragraph 3.10 Disinfection and Bacteriological Testing.

D. Provided that the bacteria sample has passed, a pressure test shall be scheduled with the City's Construction Coordinator performing the test 48 hours in advance. Testing shall be in accordance with paragraph 3.9 Pressure Test.

E. Following successfully passing the pressure test, subject the system to a final flushing until the chlorine concentration is less than 1 mg/l or no higher than that generally prevailing in the source system. Thereafter, a second bacteria sample shall be collected at regular intervals not exceeding 2000 feet and at least 24 hours following the first bacteriological sample and tested for bacteriological quality.

F. Discontinue flushing and isolate lines being tested. If the second bacteria sample has passed, the system shall be placed in service.

G. After final flushing, flow all hydrants to confirm the valves are open.

3.9 PRESSURE TESTS & LEAKAGE

The contractor shall test completed sections of water line, including service lines, fire hydrants, and fittings with water. This testing, however, does not relieve the contractor of his responsibility to repair or replace any cracked or defective pipe. All work necessary to secure a tight line shall be done at the contractor's expense. Testing shall be performed in the presence of the City of Lynchburg Engineer or Representative.

A. Pressure Test: Subject the pipe system to a hydrostatic pressure test. Raise the pressure by pump to 150 psi, or 150% of static pressure, or test pressure as shown on the drawings, whichever is greater. Measure pressure at the low point on the system compensating for gauge elevation. Maintain this pressure (+ or – 5psi) for 2 hours. If pressure cannot be maintained using reasonable pumping rate, determine cause, repair, and repeat the test until successful. Contactor shall be responsible for all labor, materials, and equipment to perform the testing. Cost shall be included in other items bid.

B. Leakage Test: During the pressure test, subject the system to a leakage test. Leakage shall be defined as the quantity of water that must be supplied into the pipe to maintain the test pressure, after all air in the pipeline has been expelled and the pipe has been tested for duration of 2 hours. Leakage shall not exceed the quantity determined by Table 6A (excerpted from AWWA C600-93), attached.

No leakage will be allowed for all welded steel pipe. If leaks are revealed by test, repair by re-welding. Peening of leaks will not be allowed. A certified welder must perform all welding.

If leakage exceeds allowances, the contractor shall be responsible for locating, repairing leaks, and retesting of line until successful, at the contractors expense.

AWWA C600 TABLE 6A
ALLOWABLE PRESSURE TEST LEAKAGE
(Allowable Leakage per 1000 ft. of Pipeline * in gph)

AVG. TEST PRESSURE PSI	NOMINAL PIPE DIAMETER - IN											
	2	3	4	6	8	10	12	14	16	18	20	24
450	0.29	0.43	0.57	0.86	1.15	1.43	1.72	2.01	2.29	2.58	2.87	3.44
400	0.27	0.41	0.54	0.81	1.08	1.35	1.62	1.89	2.16	2.43	2.70	3.24
350	0.25	0.38	0.51	0.76	1.01	1.26	1.52	1.77	2.02	2.28	2.53	3.03
300	0.23	0.35	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81
275	0.22	0.34	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69
250	0.21	0.32	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56
225	0.20	0.30	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43
200	0.19	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29
175	0.18	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15
150	0.17	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99
125	0.15	0.23	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81
100	0.14	0.20	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62

* For pipe with 18 ft nominal lengths. To obtain the recommended allowable leakage for pipe with 20 ft nominal lengths, Multiply the leakage calculated from the table by 0.9. If the pipeline under test contains sections of various diameter, the allowable leakage will be the sum of teh computed leakage for each size.

** This table is excerpted from AWWA C-600, Section 5.2 Table 6A

3.10 DISINFECTION AND BACTERIOLOGICAL TESTING

Pipe Disinfection and Bacteriologic Testing: comply with AWWA C-651, Disinfecting Water Mains. The contractor shall disinfect water mains and accessories in accordance with the procedures listed below and meet the requirements of authorities having jurisdiction. Bacteriological testing shall comply with Section 5 of AWWA C651. All samples shall be tested for bacteriological (chemical and physical) quality in accordance the Standard Methods for the Examination of Water and Wastewater; and shall show the absence of coliform organisms and the presence of chlorine residual.

A. Forms of Chlorine

1. Calcium hypochlorite – Two forms are available – granular and tablets (both with 65% available chlorine). It will normally require 6.5 lbs. of Calcium Hypochlorite to produce a concentration of 50mg/L of available chlorine in 10,000 gallons of water.
2. Sodium hypochlorite – is supplied in strengths of 5.25% to 16% available chlorine. The required amount of sodium hypochlorite to produce a 50mg/L concentration of available chlorine in 10,000 gallons of water can be calculated from the following formula:

   Gallons of Sodium Hypochlorite needed = 50 ÷ % of available chlorine

B. Methods of Chlorine Application

1. Application for Tablet Method – This method shall be the primary method of applying chlorine to a water distribution system unless nonpotable water or foreign materials have entered the mains or if the water temperature is below 5° C (41° F).

   The tablets shall be placed in each section and in all appurtenances. Enough tablets shall be used to insure that a chlorine concentration of 50 mg/L is provided in the water. They shall be attached by an adhesive to the top of the pipe sections and crushed or rubbed in all appurtenances. The adhesive shall be approved for use in a potable water system. When filling, the velocity of the potable water in the main shall be less than 1 ft./sec. The water shall then remain in contact with the pipe for 24 hours. All valves and appurtenances shall be operated while the chlorinated water remains in the main.

2. Application for Continuous Feed and Slug Method

   Taps will be made at the control valve at the upstream end of the line and at all extremities of the line including valves. These taps shall be located in such a manner as to allow Chlorine solution to be fed into all parts of the line.

   The Chlorine solution shall be circulated in the main opening of the control valve while systematically manipulating hydrants and taps at the line extremities. The Chlorine solution must be pumped in at a constant rate for each discharge rate in order that a uniform concentration will be produced in the lines.

   a. Continuous Feed Method – Potable water shall be introduced into the pipe main at a constant flow rate. Chlorine shall be added at a constant rate to this flow so that the chlorine concentration in the water in the pipe is a least 50mg/L. The chlorinated water shall remain in the main at least 24 hours, after which, the chlorine concentration in the water shall be at least 10mg/L. All valves and appurtenances shall be operated while the chlorinated water remains in the main.

b. Slug Method – Potable water shall be introduced into the main at a constant flow rate. This water shall receive a chlorine dosage, which will result in a chlorine concentration of 100 mg/L in a "slug" of the water. The chlorine shall be added long enough to insure that all portions of the main are exposed to the 100mg/L chlorine solution for at least 3 hours. The chlorine residual shall be checked at regular intervals determined by the City Construction Coordinator but not exceeding 2,000 feet to insure that adequate residual is maintained. As the chlorinated water passes valves and appurtenances, they shall be operated to insure disinfecting of these appurtenances.

C. Bacteriologic Tests: Before the water main is placed in service, all samples shall be collected at regular intervals not exceeding 2,000 feet and tested for bacteriologic quality and shall show the absence of both background growth (gram positives) and coliform organisms. The City will collect at least two samples; 1 taken prior to pressure testing and the second following the testing process, at least 24 hours apart. The samples shall be tested by the Department of Water Resources.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate. Results cannot be read until 24 hours after sample has been run by lab. If laboratory results indicate the presence of coliform bacteria, the samples are unsatisfactory. If laboratory results indicate background growth masking the detection of coliform bacteria, the sample will be considered unsatisfactory. The disinfecting shall be repeated until the samples are satisfactory. In the event that 2 successive bacteriological tests fail, the section of the main shall be re-chlorinated by the contractor and new tests performed prior to moving to the next section of main. The tablet method cannot be used in repeated disinfecting. Cleaning and disinfecting will be the responsibility of the contractor. The City will furnish water and operate all necessary valves for these operations. The contractor shall be responsible for loading, hauling and discharging of water.

Samples for bacteriological analysis shall be collected for each section of pipe between main line valves after flushing is completed.

Samples that are delivered to the College Hill Filter Plant, 525 Taylor Street, for testing shall be delivered no later than 2 PM Monday through Thursday. A chain of custody shall accompany the samples and both delivered to the plant.

Sampling will be allowed at hydrants if available to flush and sample the entire section of newly laid pipe. Otherwise, the contractor shall install a flushing and sampling tap consisting of a corportaion stop installed in the pipe with a temporary copper gooseneck assembly. Such additional work required for this shall be at the contractor's expense.

D. Pipe subjected to contaminating materials shall be treated as directed by the Engineer. Should such treatment fail to cleanse the pipe, replacement shall be required.

E. Services shall be included in the main line disinfection process. The contractor shall have the same responsibility for laterals as for the mains in regard to bearing full cost of any corrective measures needed to comply with either the bacteriological test or other such requirements.

3.11 DECHLORINATION

A. Discharge of highly chlorinated water will require proper disposal and/or dechlorination. Discharge of highly chlorinated water into available sanitary sewer lines is preferred. If sanitary sewer lines are not available, dechlorination of the highly chlorinated water will be required. All water discharge must meet all applicable Federal, State, and local codes, regulations and guidelines.

END OF SECTION

SECTION 33 4100

STORM UTILITY 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. This section includes all equipment, labor, material, appurtenances, and services required for complete installation of storm drainage piping, ditches, structures, and specialties for municipal drainage systems.

1.3 DEFINITIONS

A. For the purposes of this specification, the following definitions refer to storm water drainage systems and structures that come under the authority of the City of Lynchburg, Virginia as specified within this section and other sections of this manual.

Public Storm Drainage System: Drainage systems and their appurtenances required for the conveyance of public storm water from and across publicly maintained streets, roads, highways, and other public property and located within public rights-of-way and/or easements.

1.4 SUBMITTALS

A. Submit shop drawings on all non-standard products/materials.

B. Submit product data and shop drawings for the following in accordance with Section 01000, *General Requirements*.
1. Drop/curb inlets
2. Frame and covers
3. Head/end walls
4. Inlet grates
5. Pipe and piping specialties
6. Precast concrete manhole castings

1.5 QUALITY ASSURANCE

A. Materials and operations shall comply with the latest revision of all applicable Codes and Standards.

B. Piping materials shall be marked clearly and legibly.

1. Reinforced Concrete Pipe shall be marked as follows:

   a. Pipe Class
   b. Manufacturer

2. Plain Concrete Pipe shall be marked as follows:

   a. Pipe Class
   b. Manufacturer

3. Ductile Iron Pipe shall show identification marks on or near bell as follows:

   a. Weight,
   b. Class or nominal thickness
   c. The letters “DI” or “Ductile,”
   d. Manufacturer’s identifying mark
   e. Year in which pipe was made
   f. Casting period.

4. Polypropylene Pipe shall be marked as follows:

   a. ASTM Designation
   b. Nominal Size
   c. The Legend PP(as required per ASTM F2736 and ASTM F2764)
   d. Manufacturer’s name, trade name or trademark
   e. Originating Plant Location
   f. Date of Manufacture

1.6 STANDARD ABBREVIATIONS

AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
ANSI	American National Standards Institute
AREA	American Railway Engineers Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
CRSI	Concrete Reinforcing Steel Institute
DIP	Ductile Iron Pipe
FS	Federal Specifications
MSDS	Material Safety Data Sheets
NCMA	National Concrete Masonry Association
OSHA	Occupational Safety and Health Administration
PCP	Plain Concrete Pipe
PP	Polypropylene Pipe
RCP	Reinforced Concrete Pipe
VDOT	Virginia Department of Transportation

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pipe Condition/Pipe Examination

1. New Pipe Inspection: Inspect materials thoroughly upon arrival. Examine materials for damage. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications. Check bells and spigots closely for smoothness, roundness, and honeycombing (concrete pipe), which maybe a source of infiltration. Check for cracks, chips, etc. on both ends. Reject any pipe that will not provide watertight seal or is otherwise structurally deficient.

2. Pre-Installation Inspection: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipe damaged or deemed not to conform to these specifications shall be rejected and removed from site. All pipe in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells must be true.

B. Protect pipe coating during handling using methods recommended by the manufacturer. Use of-bare cables, chains, hooks, metal bars, or narrow skids in contact with coated pipe is not permitted.

C. Observe manufacturer's directions for delivery and storage of materials and accessories.

D. Protect stored piping from entry of water or dirt into pipe. Protect bells and flanges of special fittings from entry of moisture and dirt.

E. Handle precast concrete manholes and other structures according to manufacturer’s written rigging instructions.

1.8 COORDINATION

A. Coordinate tie-in to municipal drainage systems with the City of Lynchburg City Engineer.

PART 2 - PRODUCTS

2.1 PIPE & FITTINGS

A. DUCTILE IRON PIPE

1. Ductile Iron Pipe

Ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA C151/ANSI A21.51 and ASTM A746, *Standard Specification for Ductile Iron Gravity Sewer Pipe* for 4-inch and larger diameter pipe, thickness class rated, class 50 minimum. The thickness of Ductile Iron Pipe shall be determined by considering trench load in accordance with ANSI/AWWA C150/A21.50. Minimum laying length shall be 18 feet except for tie-in at a structure.

The ductile iron pipe shall be cement mortar lined with a seal coat in accordance with ANSI/AWWA C104/21.4. Outside coat shall be a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.21 Section 51-8.1.

Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, United States Pipe and Foundry Company, Griffin Pipe Products Company, or McWane Cast Iron Pipe Company.

2. Ductile Iron Joints

Pipe joints may be either push-on or mechanical joint pipe sizes 4 inches through 48 inches in diameter. Rubber Gasket Joints and Mechanical Joints shall comply with AWWA C111/ANSI A21.11, ASTM A536 *Standard Specification for Ductile Iron Castings*. Acceptable pipe joints are as follows:

a. Push-on Joint Ductile Iron Pipe shall conform to AWWA C151/ANSI A21.51 (such as *"Fastite," "Tyton,"* or *"Bell-Tite."*). The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, and comply with AWWA C111/ANSI A21.11.

b. Mechanical Joint, Ductile Iron Pipe shall be used only at the specific locations indicated on the drawings or as approved by the City Engineer.

1) The mechanical joint shall consist of:
   a. A bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting;
   b. A pipe or fitting spigot;
   c. A sealing gasket;
   d. Separate ductile iron follower gland having cored or drilled bolt holes; and
   e. Ductile iron tee head bolts and hexagon nuts.

2) The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe or fitting while maintaining a leak proof joint connection. The mechanical joint shall conform to the requirements of Federal Specification WW-P-421, AWWA C111/ANSI A21.11, and ASTM A 536 Standard Specification of Ductile Iron Castings.

B. PLAIN CONCRETE PIPE (PCP)

PCP shall be a minimum of Class III, Wall B. Concrete pipe joints shall be tongue and groove type unless otherwise specified. PCP pipe shall conform to the requirements of applicable sections of the latest revisions of the VDOT Road and Bridge Specifications.

PCP shall also meet ASTM C14, *Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe,* Extra Strength.

Gasketed Joints in Concrete Pipe shall meet ASTM C990, *Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*, latest revision.

C. REINFORCED CONCRETE PIPE (RCP)

RCP shall be a minimum of Class III, Wall B. Concrete pipe joints shall be tongue and groove type unless otherwise specified. RCP shall conform to the requirements of applicable sections of the latest revision of the VDOT *Road and Bridge Specifications*.

RCP Class III or IV shall also meet ASTM C76, *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*.

Gasketed Joints in Concrete Pipe shall meet ASTM C990, *Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*, latest revision.

D. Polypropylene Pipe (PP)

PP shall conform to the requirements of ASTM F2736-10, *Standard Specification for 6 to 30 in. (152 to 762mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe* and ASTM F2764-10, *Standard Specification for 30 to 60 in (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications*. Gasketed joints for High Pressure (HP) pipe shall meet ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe* and ASTM D3212, *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Elastomeric Seals*; latest revision.

2.2 MISCELLANEOUS APPURTENANCES

A. BEDDING

See Section 02220, *Trenching, Backfilling, and Compaction of Utilities.*

B. CONCRETE BLOCK

Concrete block shall conform to the requirements of ASTM C139, *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*.

C. BRICK

Brick shall be hard clay, grade SM, ASTM C 32, *Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)* and AASHTO M91.

D. MORTAR FOR CONCRETE BLOCK & BRICK

Mortar shall be type M, ASTM C 270, *Standard Specification for Mortar for Unit Masonry* and ASTM C 144, *Standard Specification for Aggregate for Masonry Mortar*. Mortar shall be prepared from cement in perfect condition and shall be prepared in boxes for that purpose. No

mortar that has stood beyond forty-five minutes shall be used. Proportion by volume for the different types of application shall be as follows:

Brick masonry =	1 part cement to 2 parts sand
Pointing =	1 part cement to 1 part sand

E. MISCELLANEOUS CONCRETE

Concrete Classes (VDOT) to Design Compressive Strength at 28 days (f'c):

Class A4.5General4,500-psi Class A4General4,000-psiClass A3General3,000-psiClass B2Massive or Lightly Reinforced2,200-psi

Ready mixed concrete shall comply with ASTMC94, *Standard Specification for Ready-Mixed Concrete.* All exposed concrete shall be air entrained. Concrete strength shall be as specified on standard details and drawings. Unless otherwise specified, all concrete shall be ClassA3, minimum.

F. PORTLAND CEMENT

Type I, CSA normal, ASTM C150 *Standard Specification for Portland Cement.*

G. PRECAST REINFORCED CONCRETE STRUCTURES

Manholes of precast reinforced concrete shall be designed and manufactured in accordance with ASTMC478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, or latest revision. Manhole diameters shall be 4-foot minimum. The wall shall be a minimum of5 inches thick and have a 6-inch minimum base. Man holes shall be of precast concrete manhole risers with a tongue and groove joint and a monolithic precast bottom, except where doghouse bases are to be used when placing manholes over existing mains. Joints shall be sealed with a minimum of butile mastic in conformance with AASHTO M 198, latest revision.

Manhole steps are not permitted.

Unless otherwise approved by the City Engineer, manholes will be precast reinforced concrete.

Manholes over12 feet in depth, as measured from top of casting to effluent invert, shall have extended bases with appropriate reinforcing.

H. MANHOLE FRAMES AND COVERS

Standard Frames and Covers: Manhole frames and covers shall be manufactured from Class 30 gray iron, meeting the requirementsofASTMA48, *Standard Specification for Gray Iron Castings*. Standard manhole frames and covers shall be manufactured to the dimensions and configurations shown on Standard Details 27.10 and 27.11and shall have a minimum of 4 1-inch diameter holes in the flange of the frame. Minimum inside diameter of the opening shall be 24 inches. Manholes castings may be either bituminous coated or plain. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame with-

out rocking. Covers are to be embossed along the perimeter with the words “Storm.” Approved castings are the US Foundry 710 ring and DP cover, East Jordan Iron Works2027 frame and cover, or approved equal.(See Standard Details 27.10 & 27.11).

A Vulcan V-1883 is to be used with flat top manholes.

I. DROP INLETS

a. Drop inlet tops shall be precast and shall conform to the requirements of all applicable sections of the latest revision of VDOT *Road and Bridge Specifications and Standards*.
b. Drop inlet bases shall be precast and shall conform to the requirements of all applicable sections of the latest revisions of the VDOT *Road and Bridge Specifications and Standards*.
c. Unless otherwise approved by the City Engineer, all drop inlet tops and bases will be precast reinforced concrete.
d. Inlet Grates shall conform to the requirements of all applicable sections of the latest revision of the VDOT *Road and Bridge Specifications and Standards*.
e. All storm drain inlets shall be labeled with a message such as "No Dumping, Drains to River" either by attached labels or by letters cast into the manhole cover or grate. Attached labels shall be at least four inches in diameter. Labels shall be stainless steel or aluminum as manufactured by Almetek Industries or approved equal. If a cast message is used, cast letters must be at least one inch in height.

J. MISCELLANEOUS STORMWATER APPURTENANCES

All miscellaneous stormwater appurtenances including but not limited to endwalls, headwalls, and flared end sections shall conform to all applicable sections of the latest revision of VDOT *Road and Bridge Specifications and Standards.*

PART 3 – EXECUTION

3.1 PIPE INSTALLATION - GENERAL

A. CONSTRUCTION – ALL PIPE

1. Trench Width: Trench width shall be per Standard Detail 27.01.
2. Minimum Bury Requirements: Minimum cover shall be in accordance with manufacturer’s recommendations.
3. Pipe Laying Direction: Place piping beginning at low point and progress uphill. Place on grade, with unbroken continuity in invert, horizontally and vertically, and on alignment as indicated on plans. Place bell ends of piping facing upstream. Install gaskets, seals, sleeve, and couplings according to manufacturer’s written instructions for using lubricants, cements, and other installation requirements.
4. Directional Changes in Gravity Lines: Use manholes for changes in direction of gravity lines.
5. Stringing out Pipe: When pipe is strung out during unloading, it shall be set on high ground and in a position to prevent silt deposits, storm water, or other matter from entering the pipe prior to its placement in the trench.
6. Pipe Laying: Pipe shall be bedded per Section 02220 – *Trenching, Backfilling and Compaction of Utilities*. The pipe and fittings shall be laid in the trench so that its interior sur-

face shall conform to the grade and alignment as shown on the plans. Pipe laying shall be done in such a way as to disturb as little as possible the pipe that has already been laid. The alignment and grade of the storm main may be field adjusted whenever, in the opinion of the City Engineer, it is necessary, so long as the changes are consistent with the City of Lynchburg policy in affect at the time of the change. Changes in either grade or alignment may only occur at manholes.

Before laying, the bell and spigot will be wiped free from any dirt or other foreign matter. All surfaces of the portion of the pipe to be joined, and the factory-made jointing material, shall be clean and dry. Jointing material shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing material or factory-fabricated joints shall then be placed, fitted, and adjusted in such workmanlike manner as to obtain the degrees of water tightness required.

Trenches shall be kept as dry as possible during bedding, laying and jointing and for as long a period as required until the trench is backfilled. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line or grade.

The greatest care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time.

After the trench foundation has been properly graded to receive the pipe, the pipe shall be carefully lowered into the trench with approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be replaced at the Contractor's expense.

At least 4 joints shall be left exposed for inspection purposes during the working day and a suitable ladder affording easy and safe access for such inspection shall be furnished.

Any defects due to settlement shall be made good by the Contractor at his own expense.

7. Temporary Suspension of Work: When the trench is left for the night or if pipe laying is suspended, the upper end of the pipe shall be plugged to keep out dirt, water, animals and other foreign matter or substances. This plug shall be kept in the end of the pipe line at all times when laying is not in actual progress.

8. Cutting or Fitting Pipe: Whenever a pipe requires cutting to bring a pipe to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools which will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe. The method of cutting pipe shall be in accordance with manufacturer's recommendations. Such cuts shall be made by the Contractor without extra compensation.

B. DUCTILE IRON PIPE

1. Bury limitations shall govern as follows based on the type laying condition:

Table 27.1			
Bury Limitations on DIP			
Pipe	Maximum Bury to Invert of Pipe[a]		
	Type 2 Laying Condition – Equivalent to Class D Bedding	Type 4 Laying Condition - Equivalent to Class C Bedding (See Detail 27.01)	Type 5 Laying Condition - Equivalent to Class B Bedding (See Detail 27.01)
8-inch DIP, Class 50	20 feet	34 feet	50 feet
10-inch DIP, Class 50	15 feet	28 feet	45 feet
12-inch DIP, Class 50	15 feet	28 feet	44 feet
14-inch DIP, Class 50	14 feet	27 feet	44 feet
16-inch DIP, Class 50	15 feet	28 feet	44 feet

[a]Laying condition **Type 2** is a flat bottom trench with backfill lightly compacted to centerline of pipe (equivalent to Class D). Laying condition **Type 4** is a 4-inch bed of stone with pipe embedded to 1/8 pipe diameter (equivalent to Class C bedding). **Type 5** laying condition is also a 4-inch bed of stone with pipe embedded to the spring line of the pipe (equivalent to a Class B).

2. Ductile Iron Pipe is approved for all storm uses within City Right-of-Way/Easements.

C. REINFORCED CONCRETE PIPE

1. Pipe support for pipe shall provide uniform bearing for the pipe barrel along its entire length.
2. Minimum Pipe Bedding Class: See Section 02220, *Trenching, Backfilling and Compaction of Utilities*, paragraph 3.3.2 for minimum bedding requirements.
3. Pipe with varying wall class must not be mixed between manholes or boxes.

4. Bury Limitations: Table 27.2shallgovern as the maximum allowable bury for concrete storm pipe:

Table 27.2				
Bury Limitations on RCP (15 through 60 inches)				
Pipe Class	Maximum Depth of Bury[a]			
	Class III (feet)	Class IV (feet)	Class V (feet)	Max Trench Width (feet)
15-inch	9.5	14.5	23.0	4.0
18-inch	9.5	15.0	32.5	4.0
24-inch	11.5	23.0	50.0	4.0
30-inch	11.0	19.5	44.5	5.0
36-inch	10.5	18.0	35.0	6.0
42-inch	11.0	19.0	36.5	6.5
48-inch	11.5	19.5	37.5	7.0
54-inch	12.0	20.0	38.5	7.5
60-inch	12.0	20.5	38.5	8.0

[a] Based on saturated clay weighing 120 pcf, trench width as specified, class C stone bedding, 1350 plf per ft of internal diameter for class III and 2000 plf per ft of internal diameter for class IV, 3000 plf per ft of internal diameter for class V, D-0.01 crack

5. Join concrete pipe using bitumastic material to seal joint.

6. As each joint is laid, visually inspect to be certain that no jointing compound gasket, or trash is protruding from the joint or lying inside the pipe.

D. PLAIN CONCRETE PIPE

1. Plain Concrete Pipe is approved for storm uses in non-traffic bearing situations only.
2. Pipe support for pipe shall provide uniform bearing for the pipe barrel along its entire-length.
3. Minimum pipe bedding class: *see 3.1.3, paragraph B, above*.
4. Pipe with varying wall class must not be mixed between manholes or boxes.
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5. Bury Limitations: *See Table 27.3, below*.

Table 27.3 Bury Limitations on PCP (12 through 24 inches)	
Pipe Diameter	**Maximum Depth of Bury Non Reinforced** (feet)
12-inch	9.5
15-inch	9.5
18-inch	10.5
21-inch	11.0
24-inch	11.5

6. Join concrete pipe using bitumastic material to seal joint.

7. As each joint is laid, visually inspect to be certain that no jointing compound, gasket, or trash is protruding from the joint or lying inside the pipe.

E. POLYPROPYLENE PIPE

1. PP pipe is approved for storm use in traffic and non-traffic bearing situations.

2. Pipe support for pipe shall provide uniform bearing for the pipe barrel along its entire-length.

3. Minimum pipe bedding class: See Standard Detail 27.01A. Alternate bedding class may be used only with the approval of the City Engineer as per 3.1.3, paragraph B, above.

4. Bury Limitations: *See Table 27.4, below*.

Table 27.4 Bury Limitations on HPP PP (12 through 60 inches)	
Pipe Diameter	**Maximum Depth of Bury HPP PP** (feet)
12-inch	21
15-inch	22
18-inch	19
24-inch	16
30-inch	16
36-inch	14
48-inch	12
60-inch	16

5. Join HP Pipe using gaskets to seal joint. PP pipe joints shall be double gasketed unless otherwise specified.

6. As each joint is laid, visually inspect to be certain that no gaskets have dislodged, rolled or trash is protruding from the joint or lying inside the pipe.

3.2 MANHOLE CONSTRUCTION FOR STANDARD MANHOLES AND DROP INLET BASES

A. Standard Manholes and Drop Inlet Bases: Manholes shall be constructed in accordance with Standard Details 27.02 and 27.03 with the following exceptions:

Flexible boots and precast concrete inverts will not be required.

Joints will be as specified in the product section of this specification.
The pipe opening in precast units shall be at least 4 but not more than 8 inches larger than the outside diameter of the pipe. Pipe openings shall be formed, drilled, or neatly cut as approved by the Engineer.

The contractor may use brick and masonry block or concrete pipe cutoffs in conjunction with mortar to fill the void between pipe culverts and precast structures. Such materials shall be thoroughly wetted and bonded with mortar. The remaining exterior and interior void shall be filled and sealed/slicked with mortar to the contour of the precast structure.

The standard joint shall be sealed on the interior of the structure, after installation, with a non-shrink hydraulic cement mortar per VDOT *Road and Bridge Specifications*, Section 218.

Plug all weep holes with mortar.

Pour concrete inverts in all structures. Concrete shall be in compliance with products section for miscellaneous concrete of these specifications. Shape manhole channel with a smooth semicircular bottom matching inside diameter of the connecting pipe/pipes. Change directions of flow with a smooth curve of as large a radius as the manhole size will permit. Change size and grade of channels gradually and evenly. Shape the shelf to provide a slope between 1 and 2 inches per foot towards the invert.

Manholes shall be installed plumb.

B. Grade Rings/Adjustments: The contractor shall exercise care in the ordering of structures so that the use of grade rings or brick for leveling and adjustments can be minimized. Where adjustment of a manhole is required, grade rings shall be used unless otherwise approved by the City Engineer. Where adjustment of the inlet is required, the use of bricks or grade rings is approved, provided that the entire void between the flat-top and inlet is also filled with brick and mortar to uniformly distribute loading of the inlet. The combination of grade rings or depth of bricks shall not exceed 12 inches before removal of the cone or flat-top is necessary for adjustment.

On all storm manholes, a mastic joint material shall be placed between the frame and cover and the cone or grade ring.

When applicable, during the installation of manholes, if frame and cover is near or within wheel path in roadway, turn cone to place the frame out of wheel path.

C. Replacement/Rehabilitation of Existing Manholes

When a new manhole is necessary, the old manhole must be completely removed and a new precast manhole constructed in its place. Where the old manhole is of satisfactory quality, the Contractor will make connection thereto as directed by the City Engineer at no additional cost even if it is necessary to modify the bottom of the manhole to meet the new grade. Such extras are considered to be incidental to the manhole connection cost.

3.3 INLET CONSTRUCTION AND MISCELLANEOUS APPURTENANCES

Construct inlets, end walls, and other storm drainage items as detailed in the latest edition of the VDOT *Road and Bridge Specifications and Standards*.

Adjusting inlet tops and/or miscellaneous appurtenances shall follow same guidelines as prescribed in 3.2, *Manhole Construction for Standard Manholes and Drop Inlet Bases*, paragraph B. *Grade Rings/Adjustments*, above.

All storm drain inlets shall be labeled with a message such as "No Dumping, Drains to River" either by attached labels or by letters cast into the manhole cover or grate. If attached labels are used, they shall be permanently attached by either manufacturer recommended glue or bolt. Label shall be on the top horizontal surface of inlets so it can be clearly read when looking down at the inlet.

3.4 ABANDONING STORM LINES & MANHOLES

A. Storm Lines: When an existing storm line is designated to be abandoned in place, the low end of the line is to be plugged and lean concrete grout (flowable fill) pumped into the line until line is completely filled.

B. Manholes: When an existing manhole, either partially or wholly, is designated to be abandoned and the storm lines, either entering or exiting the manhole, have been abandoned according to the preceding paragraph, the upper portion of the manhole shall be removed to a minimum of 18 inches below the proposed finished grade, or as determined by the City Construction Coordinator, VDOT #57 stone dumped into the manhole, and the stone vibrated to consolidate the stone. The remainder of the fill between the top of the manhole and the finished subgrade is to be backfilled as follows. Where the manhole is located within a roadway right of way, backfill with VDOT # 57 Stone and consolidate. Outside roadway right of ways, filter fabric shall be placed over the stone, suitable material of a compactable nature shall be placed over the top of the manhole, and the material tamped.

3.5 SLOPE ANCHORS

All lines on slopes equal to or greater than 20% slope shall have concrete anchors placed around the pipe directly below the bell end of the line. The anchors shall be spaced every other joint unless otherwise shown on the plans and constructed to the dimensions shown in Standard Detail 27.21.

3.6 EXCAVATION OF DRAINAGE CHANNELS

A. Open storm drainage channels and ditches shall be graded and shaped in accordance with the elevations, slopes, widths, and lengths indicated on the plans. The outfall elevation of the new channels and ditches shall be graded to match the flow elevations of all existing or natural channels, unless indicated or specified otherwise.

B. The drainage channels shaped with fill materials shall be compacted within the limits and in accordance with the related backfill work specified elsewhere.

C. The drainage channels shall be prepared, seeded, and mulched in accordance with the related work specified elsewhere. Where indicated or specified, erosions control measures, such as temporary liners, rip rap, concrete, etc., shall be provided.

3.7 INSPECTION

Upon completion of entire pipe installation, the City Engineer may inspect the work in part or as a whole as will satisfy himself/herself that every portion of the contract has been faithfully carried out.

If, in the opinion of the City Engineer, a defect exists in the pipeline or its appurtenances, in some place not accessible except by uncovering, the City Engineer may order the line to be uncovered. If it is found that after the pipe has been uncovered at the order of the City Engineer, no defect exists or that the defects were not the fault of the contractor, then the expense so incurred by the contractor shall be borne by the City.

Flush all sand, dirt, and debris from the lines prior to inspection. Provide lights and mirrors and inspect lines in the presence of the Construction Coordinator.

Inspect the system for conformance with line and grades shown on the plans and provide record drawing measurements on record drawings.

Visual Inspection: All sewer lines and manholes shall be visually inspected by the contractor/developer in the presence of the City Construction Coordinator from every manhole by use of mirrors and television cameras and in accordance with Section 02760 - Television Inspection of Sewer Lines. The lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines that do not exhibit a true and correct line and grade, have obstruction or structural defects, shall be corrected to meet these specifications and the sewer barrel left clean for its entire length.

END OF SECTION

SECTION 33 4600

SUBDRAINAGE

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. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.2 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.3 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 RETAINING-WALL DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

G. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

I. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.4 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches unless otherwise indicated.
2. Lay perforated pipe with perforations down.
3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping according to ASTM D 2321.

3.5 PIPE JOINT CONSTRUCTION

A. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches deep. Set top of cleanout 2 inches above grade.

3.7 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.

3.8 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

GREATER LYNCHBURG TRANSIT COMPANY OPERATIONS AND MAINTENANCE FACILITY

419 BRADLEY DRIVE
LYNCHBURG, VA 24501

Bid Documents

APPENDIX

September 24, 2014

Prepared For: Greater Lynchburg Transit Company
1301 Kemper Street
Lynchburg, VA 24501

Submitted by: Alexandria Architecture, Engineering, Land Surveying & Landscape Architects, Inc.
1420 King Street Suite 510
Alexandria, VA 22314

wendel

Geotechnical Investigative Report

on
GLTC Operations & Maintenance Facility
Bradley Drive
Lynchburg, Virginia

prepared for
Ms. Karolina Bazylewicz
Wendel
140 John James Audobon Pkwy
Buffalo, NY 14228

submitted to
Ms. Karolina Bazylewicz
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140 John James Audobon Pkwy
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prepared by
J. Kenneth Meritt, P.G., P.E.
Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, Virginia 24501

date
October 16, 2013

COMMONWEALTH OF VIRGINIA
J. KENNETH MERITT
Lic. No. 049743
10/16/13
PROFESSIONAL ENGINEER

Project Number: 20130553

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October 16, 2013

Ms. Karolina Bazylewicz
Wendel
140 John James Audobon Pkwy
Suite 201
Buffalo, NY 14228

HURT & PROFFITT
INCORPORATED

Re: GLTC Operations & Maintenance Facility
Lynchburg, Virginia
Subsurface Geotechnical Investigation
Project No. 20130553

Dear Ms. Bazylewicz:

Hurt & Proffitt, Inc. (H&P) has completed the requested subsurface investigation on the above referenced project. The investigation was initiated to evaluate existing site conditions and provide a geotechnical investigative report.

This investigation encompassed the following scope of services:

1. Eight (8) standard penetration borings (B-1 through B-8) were completed within the proposed building footprint. Six (6) borings were each terminated at a depth of 30.5 feet. Two (2) of the borings were terminated at auger refusal at depths of 27.5 feet and 51.5 feet. Ten (10) feet of diamond bit rock coring was completed at these 2 locations.
2. Eight (8) standard penetration borings (P-1 through P-8) were completed at various locations outside the proposed building pad. These borings were each terminated at a depth of 20 feet or auger refusal.
3. Two (2) standard Proctor analyses in accordance with ASTM D 698.
4. Two (2) Atterberg limit analyses in accordance with ASTM D 4318.
5. Two (2) washed sieve analyses in accordance with ASTM D 1140.
6. Two (2) natural moisture analyses in accordance with ASTM D 2216.
7. Two (2) California Bearing Ratio analyses in accordance with VTM-8 Modified.
8. Evaluation of ground water levels at 0 hours and at 24 hours.
9. Geotechnical investigative report preparation.

H&P appreciates the opportunity to complete this study for you. Should you have any questions in reference to this work or the site, please do not hesitate to contact us.

Sincerely,
Hurt & Proffitt, Inc.

COMMONWEALTH OF VIRGINIA
J. KENNETH MERITT
Lic. No. 049743
10/16/13
PROFESSIONAL ENGINEER

Matthew Peters
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GLTC Operations & Maintenance Facility
Bradley Drive
Lynchburg, Virginia

1.0 PROJECT INFORMATION

The GLTC Operations and Maintenance Facility site is located on Bradley Drive approximately one-tenth of a mile east of Odd Fellows Road in Lynchburg, VA. Proposed building plans indicate a single-story structure with a building footprint of approximately 200 feet by 325 feet. Based on the elevation change across the site, the utilization of site retaining walls is expected. The existing site is undeveloped and heavily wooded. Please refer to the Test Boring Location Site Plan in Appendix B.

Project Information:

Estimated maximum column loads = 150 kips.
Estimated maximum wall loads = 2 klf.
Estimated finished floor elevation (FFE) = 832.00 feet.
Estimated maximum uniform floor loads = 250 psf.
Estimated maximum concentrated floor loads = 15 kips.

Slab-on-grade construction will be utilized as well as below grade pits for maintenance, lifts, etc.

2.0 SUMMARY OF FINDINGS

Prior to the grading operations, a significant amount of site work will be required. The site is heavily vegetated with small trees and scrub overgrowth. All vegetation, topsoil, and otherwise deleterious material will need to be removed prior to the cut/fill earthwork operations. The relocation of a gas utility line may also be required. The gas line was marked by Miss Utility and parallels the front side of property along Bradley Drive.

Based on the proposed finish grades and because of the sloping terrain, cutting and filling of soils will be required to establish final subgrades across the building pad and parking lot. Maximum cut and fill depths at any one location on the site are estimated at 30± feet. All fill material should be tested and placed under controlled fill conditions (please refer to the Earthwork and Grading Section on page 4 of this report).

Residual type soil conditions were encountered during the site investigation. The soil types encountered were Elastic Silts (MH), Sandy Silts (ML), and Silty Sands (SM).

Based on the proposed cut elevations across the site, difficult excavation conditions and some rock removal may be required. Dense weathered rock and hard rock conditions were encountered along the southeast corner of the site. Auger refusal in the area of boring P-8 occurred at a depth of 13.5 feet.

Based on the proposed location and finish floor elevation for the building, the building foundations will bear on cut "virgin" type soil conditions. Standard penetration test (SPT) "N" values indicated variable soft and hard soil conditions are present across the building pad. Based on the variable and soft conditions, H&P recommends using a reduced bearing capacity of 1,500 psf for foundation design to minimize the risk of excessive total and differential settlements. In addition to the reduced bearing capacity, some column footings will need to be reevaluated after final designs have been completed and undercutting of footings may be required if heavier loads are bearing in suspect areas.

An inspection for ground water was made following the completion of all of the borings and after a 24 hour stabilization period. Ground water was measured at completion in boring B-5 and after 24 hours in borings B-5, B-7, and B-8. Ground water depths after 24 hours ranged from 23.9 feet below existing grade in boring B-5 to 38.4 feet below existing grade in boring B-7.

3.0 INVESTIGATIVE PROCEDURES

Subsurface conditions at the GLTC site were analyzed by completing 16 standard penetration test (SPT) borings. The test boring depths ranged from 12.0 feet outside the proposed building footprint to 61.5 feet inside the proposed building. Diamond bit rock coring was completed for 10 feet at two of the boring locations within the building footprint. Please refer to the Test Boring Location Map in Appendix B and to the Test Boring Logs in Appendix C.

Split-spoon soil samples from the test borings were visually classified in the field, sealed in glass jars, and brought back to our office for future reference, as needed. These samples will be discarded following a period of 90 days upon completion of the site investigation.

One combined bulk sample from borings B-8 (1' to 9' depth range) and P-7 (0' to 8' depth range) and one bulk sample from boring B-8 (9' to12' depth range) were collected for laboratory analyses.

The following laboratory analyses were completed on each bulk sample:

1. Standard Proctor analysis (ASTM D 698)
2. Atterberg limit analysis (ASTM D 4318)
3. Washed sieve analysis (ASTM D 1140)
4. Natural moisture analysis (ASTM D 2216)
5. California bearing ratio analysis (VTM-8 Modified)

Ground water levels were recorded at the completion of each of the test boring and after a 24 hour stabilization period. After taking the static water level readings, the test borings were backfilled with the auger cuttings.

The test boring locations were surveyed in the field by Hurt & Proffitt, Inc. A track excavator was used to clear access roads during the drilling operations.

4.0 GEOLOGY/SUBSURFACE CONDITIONS

Based on the Geologic Map of the Roanoke 30 x 60 Minute Quadrangle dated 1997, the underlying bedrock in the area of study has been mapped as "Pre-Cambrian" metamorphic rock units as belonging to the Alligator Back Formation. The chief lithology underlying the site is actinolite schist. Geographically, the site is located in the Blue Ridge Anticlinorium Physiographic Province and in the Southeast corner of the USGS Lynchburg, Virginia Topographic Quadrangle.

The upper subsurface profile below the surficial organic bearing topsoil zones, as described by the Unified Soils Classification System, consist of residual type soil conditions. The following is description of the subsurface materials that were encountered during the investigation.

4.1 Surficial Soils

Organic bearing topsoil materials (ground surface materials) are present over the entirety of the site. The thickness of the topsoil materials could not be verified as these materials were removed during the site clearing operations. Based on the visible topsoil along the edges of the cleared pathways, topsoil thicknesses are estimated at 6 inches to 8 inches. All topsoil and organic bearing materials should be stripped and are not considered suitable for structural fill purposes.

4.2 Residual Type Soils

The on-site residual soils have formed in place due to the decomposition of the parent rock underlying the site. The on-site residual soils are primarily Elastic Silts (MH) that transition with depth into Sandy Silts (ML) and Silty Sands (SM). The on-site fine grain elastic silts and sandy silts have general consistency of medium to hard with SPT "N" values ranging from 5 to 73. The coarse grain silty sand soils vary in density from loose to very dense with SPT "N" values ranging from 10 to 52.

4.3 Weathered Rock Conditions

Weathered rock or partially weathered rock are descriptions generally used when the Standard Penetration Tests "N" values are in excess of 50 blows per 6 inches. Typically the rock structure is preserved and the material will crush to a sandy silt or silty sand type soil. Dense weathered rock conditions were encountered in the areas of Borings B-2 (9.0'-14.0'), B-5 (30.0'), B-7 (49.0'-51.5'), B-8 (9.0'-19.0' and 24.0'-27.5'), P-5 (6.0'-12.0'), P-6 (12.0'-14.5'), P-7 (14.5'-20.0'), and P-8 (12.0'-13.5').

4.4 Hard Rock Conditions

Auger refusal was encountered in borings B-7 (51.5 feet), B-8 (27.5 feet), P-5 (12.0 feet), P-6 (14.5 feet), and P-8 (13.5 feet). Diamond bit coring was completed for an additional 10 feet after refusal in borings B-7 and B-8. The lithology of the rock core samples is consistent with the bedrock mapped in this area.

The table below lists the test boring elevation datum.

TEST BORING LOCATION	GROUND ELEV.	TEST BORING DEPTH (ft)	BOTTOM OF BORING ELEV.	CAVE IN DEPTH (ft)	DEPTH TO WATER FROM GROUND (ft)*	STATIC WATER LEVEL (SWL) ELEV.
B-1	833.9	30.5	803.4	26.0	Dry	Dry
B-2	834.1	30.5	803.6	26.0	Dry	Dry
B-3	838.1	30.5	807.6	26.6	Dry	Dry
B-4	837.4	30.5	806.9	27.0	Dry	Dry
B-5	843.3	30.5	812.8	26.8	23.9	819.4
B-6	842.2	30.5	811.7	26.4	Dry	Dry
B-7	835.8	61.5	774.3	NA**	38.4	797.4
B-8	847.2	39.4	807.8	NA**	21.6	825.6
P-1	820.6	20.5	800.1	16.9	Dry	Dry
P-2	822.4	20.5	801.9	17.2	Dry	Dry
P-3	831.7	20.5	811.2	17.4	Dry	Dry
P-4	819.4	20.5	798.9	16.8	Dry	Dry
P-5	806.9	12.0	794.9	10.0	Dry	Dry
P-6	835.6	14.5	821.1	11.0	Dry	Dry
P-7	847.4	20.5	826.9	17.0	Dry	Dry
P-8	850.8	13.5	837.3	12.6	Dry	Dry

Note: *Ground w ater depths w ere measured after a 24 hour stabalization period.
**Cave in depths not measured due to diamond bit rock coring.

Subsurface water was encountered at the completion of boring B-5 at a depth of 26.7 feet. After a 24 hour stabilization period, static water levels were measured in borings B-5 (23.9 feet), B-7 (38.4 feet), and B-8 (21.6 feet).

Seasonal fluctuations with respect to the ground water table do occur; however, based on proposed cut depths and the ground water levels measured, H&P does not anticipate ground water being encountered during the construction operations. If ground water is encountered, H&P will make recommendations in the field concerning possible under drains and soil stabilization requirements.

The project site is located on the north side of Bradley Drive approximately one-tenth of a mile from Odd Fellows Road. (Please refer to USGS Map in Appendix A). Site drainage, based on the current topographic conditions, is generally to the northwest and northeast. Elevations across the proposed site range from approximately 800 feet to 860 feet over a distance of approximately 900 feet.

The site is entirely vegetated with scrub overgrowth and small trees. An underground gas line was observed marked along Bradley Drive. This notation is only intended to state what was observed by our on-site personnel and does not intend to imply that a full survey or research was performed to locate and/or determine presence of utilities. Full investigation should be performed by others to determine extent and nature of any/all utilities in the project area.

5.0 LABORATORY RESULTS

	Sample Location Borings B-8 (1-9') & P-7 (0'-8')	Sample Location Boring B-8 (9'-12')
Proctor Dry Density (pcf)	94.0	115.0
Proctor Optimum Moisture (%)	29.0	18.4
Atterberg Liquid Limit	54	31
Atterberg Plasticity Index	19	10
Minus #200 Sieve (%)	62.8	66.2
Natural Moisture (%)	27.8	15.3
CBR Value	16.1	5.5
USCS Classification	Sandy Elastic Silt (MH)	Sandy Lean Clay (CL)

Test Methods:

1. Standard Proctor Analysis — ASTM D 698
2. Atterberg Limit Analysis — ASTM D 4318
3. Washed Sieve Analysis — ASTM D 1140
4. Moisture Content Analysis — ASTM D 2216
5. California Bearing Ratio Analysis — VTM 8 Modified

6.0 EARTHWORK AND GRADING

Prior to the earthwork operations, a significant amount of clearing and grubbing will be required. After clearing the site vegetation and prior to fill placement, site preparation should begin with the removal of existing surficial organic soils and other deleterious materials.

Following the stripping and grubbing operations, the site should be compacted and proof-rolled in the presence of a qualified geotechnical representative. Proof-rolling should be done with a fully loaded dump truck or other approved equipment across the soil subgrade. During the proof-rolling process, it is recommended that a roller pattern be established that will maximize the densification of the subgrade prior to fill placement. Proof-rolling should be performed during good weather and not while the site is wet as a result of recent rain or snow. Areas that pump, rut, weave, or are otherwise determined to be unsuitable or unstable by the geotechnical representative, should be excavated and replaced as directed by the geotechnical representative.

Based on the existing grades and proposed finish grades, maximum cut and fill depths are estimated at 30± feet.

Compacted structural fill for building areas, pavements, and wall or utility trench backfill may be constructed using on-site soils or approved off-site borrow soils.

Suitable off-site borrow soils for this area generally includes non-cohesive soils and cohesive soils (low to medium plasticity) as defined by the Unified Soils Classification System which are free of organics or other deleterious materials.

Structural fill material under and within 25 feet of future building pad areas and retaining wall areas should be placed in horizontal lifts, with an 8 inch to 9 inch loose thickness, and compacted to at least 98% of the material's maximum dry density as determined by ASTM D 698 (Standard Proctor).

Structural fill material for parking areas, field areas, retaining wall backfill, and utilities should be placed in horizontal lifts, with an 8 inch to 9 inch loose thickness, and compacted to at least 95% of the material's maximum dry density as determined by ASTM D 698 (Standard Proctor).

The following minimum density test frequencies are recommended:

1. Building pad – One compaction test per 1,000 square feet per lift.
2. Pavement Areas – One compaction test per 2,500 square feet per lift.
3. Retaining Wall Areas – One compaction test per 1,000 square feet per lift.
4. Slope Areas – One compaction test per 2,500 square feet per lift.

The site should be graded to provide positive drainage away from the proposed structures and not allow ponding of water on the building pads and pavement sections. A 2% slope across the site is recommended. On-site fill zones should be sealed prior to forecasted rain events using a smooth drum roller to promote drainage and to prevent ponding of storm water.

Excessively wet or excessively dry soils should not be used as fill materials unless the soils are properly dried or wetted to an acceptable moisture content. A moisture content range of plus or minus 3% from the optimum moisture content of the fill material is recommended.

Excavations for footings within the prepared building pad should be made in such a way as to provide bearing-surfaces that are firm and free of loose, wet, or otherwise disturbed soils. If such deleterious materials are allowed to remain below the footing, settlement will increase. Concrete for footings should be placed the same day as the bearing surface is prepared to prevent softening due to overnight rain or other moisture. We recommend that all footing-bearing surfaces be observed and probed by qualified geotechnical personnel. The footing subgrades that do not achieve the allowable soil bearing capacity should be over-excavated to the depth and lateral limits recommended by the on-site geotechnical personnel. Because of the on-site soil conditions, H&P recommends that the over-excavated material be replaced with a compacted dense graded aggregate (VDOT #21A or #21B size aggregate).

7.0 FOUNDATION DESIGN RECOMMENDATIONS

This section of the report provides recommendations for the geotechnical design aspects of the proposed GLTC Operations & Maintenance Facility. The primary requirement in evaluating the most suitable foundation system for a structure is to determine the stratum on which the structure may be safely supported. This determination includes considerations with regard to the allowable bearing capacity of the strata, anticipated structural loads, and estimated settlement to be experienced by the proposed structure(s).

Based on the subsurface conditions and provided that H&P's recommendations in this report are adhered to, H&P recommends that conventional shallow spread (column) and strip (wall) footing foundations be utilized to support the proposed structure(s). Due to the variable bearing and soft soil layers encountered, H&P recommends that foundations be designed using a reduced allowable soil bearing capacity of 1,500 psf. The reduced bearing capacity is recommended to minimize the risk of excessive total settlement and in particular, differential settlement. In addition to the reduced bearing capacity, some column footings will need to be reevaluated after final designs have been completed and undercutting of footings may be required if heavier loads are bearing in suspect areas. Recommended minimum footing widths for strip

and spread footings are 24 inches and 36 inches, respectively. The recommended minimum depth for strip and spread footings is 36 inches.

All footing subgrades should be compacted using manually-operated vibratory equipment to promote densification of any loose or disturbed materials resulting from the excavation. Following the compaction operations, the footing subgrades should be tested to ensure the allowable bearing pressures are achieved. It is very important that the concrete for footings be placed as soon as possible once the bearing surfaces are prepared. Settlements will increase if the footing subgrades are exposed to atmospheric conditions for an extended period of time.

7.1 FLOOR SLAB CONSTRUCTION

Floor slabs may be designed as slab-on-grade. A minimum 6" layer of stone should be placed beneath the grade slabs located in the garage area. Based on the expected floor loads, H&P recommends using VDOT #21A or #21B stone compacted to at least 98% of the material's maximum dry density as determined by ASTM D 698 (Standard Proctor).

A minimum 4" layer of stone should be placed beneath the grade slabs in the office areas. VDOT #57 stone may be used in this area.

A vapor barrier should be used beneath the floor slab if an impermeable floor finish is applied to the floor. A vapor barrier may also be required if moisture sensitive equipment and/or moisture sensitive floor coverings are to be in direct contact with the floor. Vapor barriers can result in excessive curling of floor slabs during curing. For this reason, H&P recommends that the floor slab designer refer to ACI 302.1R-96, Sections 4.1.5 and 11.11 for further discussion associated with concrete shrinkage, curling, and the use of vapor barriers.

In order to minimize cracking due to settlement, it is recommended that the grade slabs be poured independent of wall footings. Isolation joints should be constructed around columns and along bearing walls to minimize cracking associated with minor settlement. Proper jointing for non-reinforced concrete should be completed to minimize cracking. Joint spacings, as suggested by ACI, should be placed at 24 to 36 times the slab thickness.

Based on the elastic silt type on-site soils, H&P recommends using a subgrade modulus (k) of 100 pci.

8.0 RETAINING WALL CONSTRUCTION

Project retaining walls and below grade foundation walls must be designed to resist all lateral pressures that will be imposed. The most common conditions used for retaining wall design are "at rest" and "active" conditions. Below grade walls that are not allowed to rotate such as rigid basement structures and tunnel structures should be designed using "at rest" earth pressures. Walls where some rotation and movement may occur to mobilize soil shear strength such as free standing retaining walls should be designed using "active" earth pressures. A third condition is the "passive" condition that develops when the base of the retaining wall structure or wall footing moves laterally into the soil. The wall translation to reach the passive state is at least twice that required to reach the active earth pressure state. For this reason, H&P recommends, for design purposes, that the calculated passive earth pressure be reduced by one-half to two-thirds.

Preliminary design plans call for one retaining wall in the southeast corner of the site along the cut slope and another retaining wall in the northwest corner along the driver training area. Based on the boring results in these areas, H&P recommends an allowable soil bearing capacity of 3,000 psf for walls bearing on residual soils. The allowable soil bearing capacity should be reduced to 2,000 psf for wall foundations bearing on compacted fill material that is placed under controlled fill conditions. H&P should be notified if retaining walls will be utilized in other areas and an allowable soil bearing capacity will be provided based on the soil boring logs in the area.

Based on the subsurface investigation and the laboratory analyses, the predominant on-site soils in the proposed cuts are elastic silts (MH). This type of soil is **not** recommended to be used as backfill material. H&P recommends a granular material for wall backfill meeting the following minimum design parameters.

- Allowable soil bearing capacity for walls bearing on residual soils = 3,000 psf
- Allowable soil bearing capacity for walls bearing on fill material = 2,000 psf
- Moist Soil Density = 120 pcf
- Effective Internal Friction Angle (phi) = 30 degrees
- "At Rest" Earth Pressure Coefficient (K_o) = 0.50
- "Active" Earth Pressure Coefficient (K_a) = 0.33
- "Passive" Earth Pressure Coefficient (K_p) = 3.0
- Equivalent Fluid Pressure for At Rest Condition = 60 psf/ft depth
- Equivalent Fluid Pressure for Active Condition = 40 psf/ft depth
- Coefficient of Friction to resist sliding between concrete wall foundations and underlying soils = 0.35

H&P's recommendations assume that a constantly functioning drainage system is installed between the wall and the soil backfill to prevent the build-up of hydrostatic pressures. H&P recommends using an open graded stone (VDOT #57 size aggregate) directly against the wall. The stone should extend from the bottom of the wall to just below the top of the subgrade and be a minimum of 1 foot in width. A foundation drain should also be installed to remove water away from the retaining wall structure. H&P's recommendations also assume the ground surface above the wall is level. The effect of surcharge loads should be added to the recommended earth pressures to determine total lateral stresses.

Heavy equipment should not be used in close proximity to retaining walls. The use of heavy equipment adjacent to retaining walls can result in excess wall movement and increased lateral earth pressures. Lightweight equipment such as hand-operated tampers should be used for compaction. Heavy equipment should not be utilized within the construction zone measured at a 45-degree angle from the base of the wall structure.

Alternative Backfill Recommendations Using VDOT #57 size aggregate

For design purposes, the following crushed stone parameters are recommended.

- Crushed Stone Unit Weight = 115 pcf (approximated, will vary depending on quarry selection)
- Effective Internal Friction Angle (phi) = 40.0 degrees
- "At Rest" Earth Pressure Coefficient (K_o) = 0.36
- "Active" Earth Pressure Coefficient (K_a) = 0.22
- Equivalent Fluid Pressure for At Rest Condition = 41 psf/ft depth
- Equivalent Fluid Pressure for Active Condition = 25 psf/ft depth
- Coefficient of Friction to resist sliding between concrete wall foundations and underlying soils = 0.35

If #57 stone is used for backfill, the stone should extend from the heel of the wall footing to a width at the top of the wall that measures 0.5 times the wall height. The stone should be placed in maximum 18-inch thick lifts and compacted with backhoe bucket or equivalent compacted effort. A geo-textile filter fabric should be placed between the crushed stone and the existing fine grained soils or new soil fill materials. H&P's recommendations assume that a constantly functioning drainage system is installed between the wall and the crushed stone backfill to prevent the build-up of hydrostatic pressures. A foundation drain should also be installed to remove water away from the retaining wall structure. H&P's recommendations also assume the ground surface above the wall is level. The effect of surcharge loads should be added to the recommended earth pressures to determine total lateral stresses.

Heavy equipment should not be used in close proximity to retaining walls. The use of heavy equipment adjacent to retaining walls can result in excess wall movement and increased lateral earth pressures. Lightweight equipment such as hand-operated tampers should be used for compaction. Heavy equipment should not be utilized within the construction zone measured at a 45-degree angle from the base of the wall structure.

9.0 PAVEMENT DESIGN

Laboratory California Bearing Ratio (CBR) testing was completed during this site investigation. Based on the CBR results, a design CBR value of 7.2 should be used for designing pavement sections. The recommended resiliency factor (RF) is 1.5. Using a design CBR value of 7.2 and RF value of 1.5, the soil support value (SSV) computes to 10.8.

Final soil subgrades should be compacted to a minimum of 98% of the soil's maximum dry density as determined by a Standard Proctor (ASTM D 698). A proof roll should be completed on the soil subgrade prior to placement of any crushed stone. Proof roll should be completed in the same manner as described in the Earthwork and Grading Section in Section 6 of this report. Crushed stone subgrades should be compacted to 98% of the material's maximum dry density as determined by a Standard Proctor or as determined by a roller pattern.

Based on an estimated volume of traffic of 500 vehicles per day, 50% heavy vehicle traffic, and the anticipated wheel loads, the recommended minimum pavement designs for the facility are as follows:

Flexible Asphalt Concrete Sections:

Heavy Duty Pavement - 16"

Subbase	10"	of Untreated #21B VDOT Size Aggregate
Base	4"	of BM-25.0
Surface	2"	of SM-9.5D

Light Duty Pavement - 10"

Subbase	8"	of Untreated #21B VDOT Size Aggregate
Surface	2"	of SM-9.5D

Rigid Portland Cement (PC) Concrete Sections:

Heavy Duty Pavement

10" x 0.14 = 1.40
6" x 0.44 = 2.64
Structural Number (S.N.) = 4.04
Concrete Thickness: 4.04/0.50 =8.0"

Light Duty Pavement

8" x 0.14 = 1.12
2" x 0.44 = 0.88
Structural Number (S.N.) = 2.00
Concrete Thickness: 2.00/0.50 = 4.0"

10.0 ANTICIPATED SETTLEMENT

Based on the subsurface conditions that were encountered during the investigation; the engineering properties of the soils; the maximum estimated loads; and the standard penetration results, maximum total settlements, if the recommendations in this report are adhered to, are estimated at less than 1 inch.

11.0 SLOPE STABILITY

A detailed slope stability analysis was not completed as part of this site investigation. Based on the predominantly elastic silt soil conditions, no permanent slopes should be steeper than 2H to 1V (horizontal to vertical). For long term stability and maintenance considerations, 3H to 1V (horizontal to vertical) is recommended.

Appropriate measures should be taken to prevent excess surface storm water from impacting the fill slopes and retaining wall areas. Both temporary berms and slope drains should be utilized until permanent diversion structures are in place.

Surface protection measures including erosion control fabric and protective vegetation cover should be implemented immediately following the slope construction operations.

H&P recommends that building foundations be placed no closer than 15 feet from the top of slopes and retaining wall structures. Also, H&P recommends that pavement sections be placed no closer than 10 feet from the top of slopes and retaining wall structures.

The Department of Labor Occupational Safety and Health Administration (OSHA) current guidelines for sloping, benching, and shielding stated in 29 CFR PART 1926 Subpart P should be adhered to for the construction of all temporary slopes and shoring more than 5 feet in height. Based on the majority of the soil types encountered on the project site, H&P recommends that all soils be classified as Type B soil and that all precautions listed for this type soil are exercised. No temporary slopes should be steeper than 1H to 1V (horizontal to vertical) for excavations less than 20 feet in depth. Sloping or benching for excavations greater than 20 feet in depth shall be designed by a registered professional engineer.

12.0 FROST DEPTH

Based on the estimated settlements and in consideration of the wind uplift forces, the recommended minimum footing depth is 36 inches below finish soil subgrade elevations.

13.0 SEISMIC CLASSIFICATION

In accordance with the International Building Code 2009, a site class seismic rating is required to complete the structural engineering analysis. Based on the standard penetration results and the unknown depth to bedrock, a "D" site class seismic rating is recommended in evaluating the foundation designs for the new building structures.

The mapped Spectral Response Acceleration at short periods is $S_s \leq 0.25$. The mapped Spectral Response Acceleration at one-second periods is $S_1 \leq 0.1$. Site coefficient values of $F_a = 1.6$ and $F_v = 2.4$ correspond to the site class and mapped spectral response accelerations.

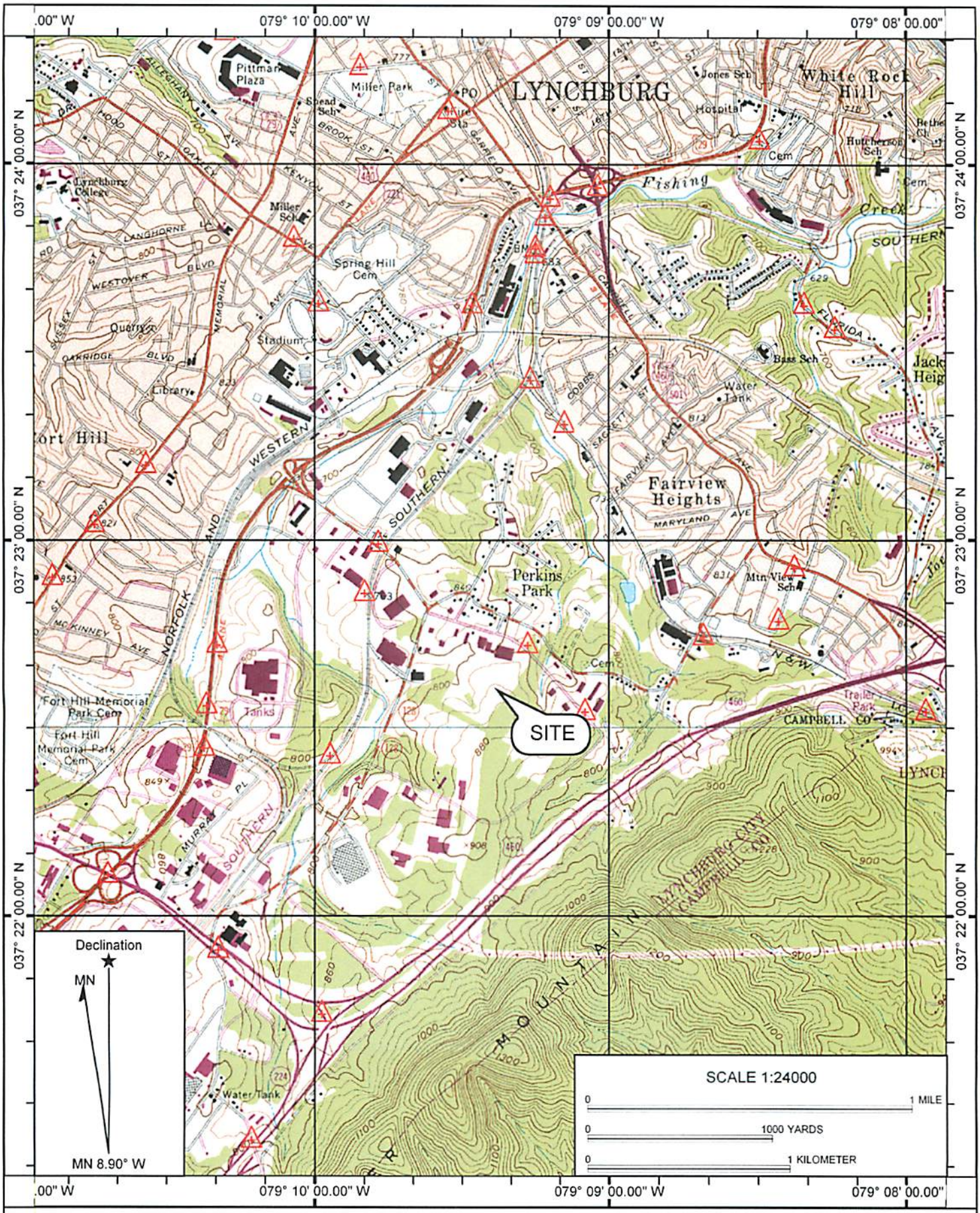
14.0 LIMITATIONS

The analyses and recommendations submitted in this report are based upon data obtained from soil borings performed at the locations shown on the Test Hole Location Map in Appendix B. Variations that may occur between these borings and other unexplored areas of the site are not reflected in this report. The nature and extent of variations between these borings may not become evident until construction is underway. If variations become apparent, H&P should be notified immediately to observe site conditions and to make appropriate recommendations.

This report has been prepared for the exclusive use of Wendel and their authorized representatives for the design of the GLTC Operations & Maintenance Facility. The conclusions and recommendations made in this report are based on the data obtained in the subsurface geotechnical investigation as described in this report and on the design information furnished to H&P for this project. H&P's recommendations are in accordance with generally accepted soil and foundation engineering practices. No warranty, express or implied, is made by H&P. Interpretations of this report by anyone other than H&P may not be valid.

Appendix A

USGS Topographic Map



Name: [Lynchburg]
Date: 10/08/13
Scale: 1 inch = 2,000 ft.

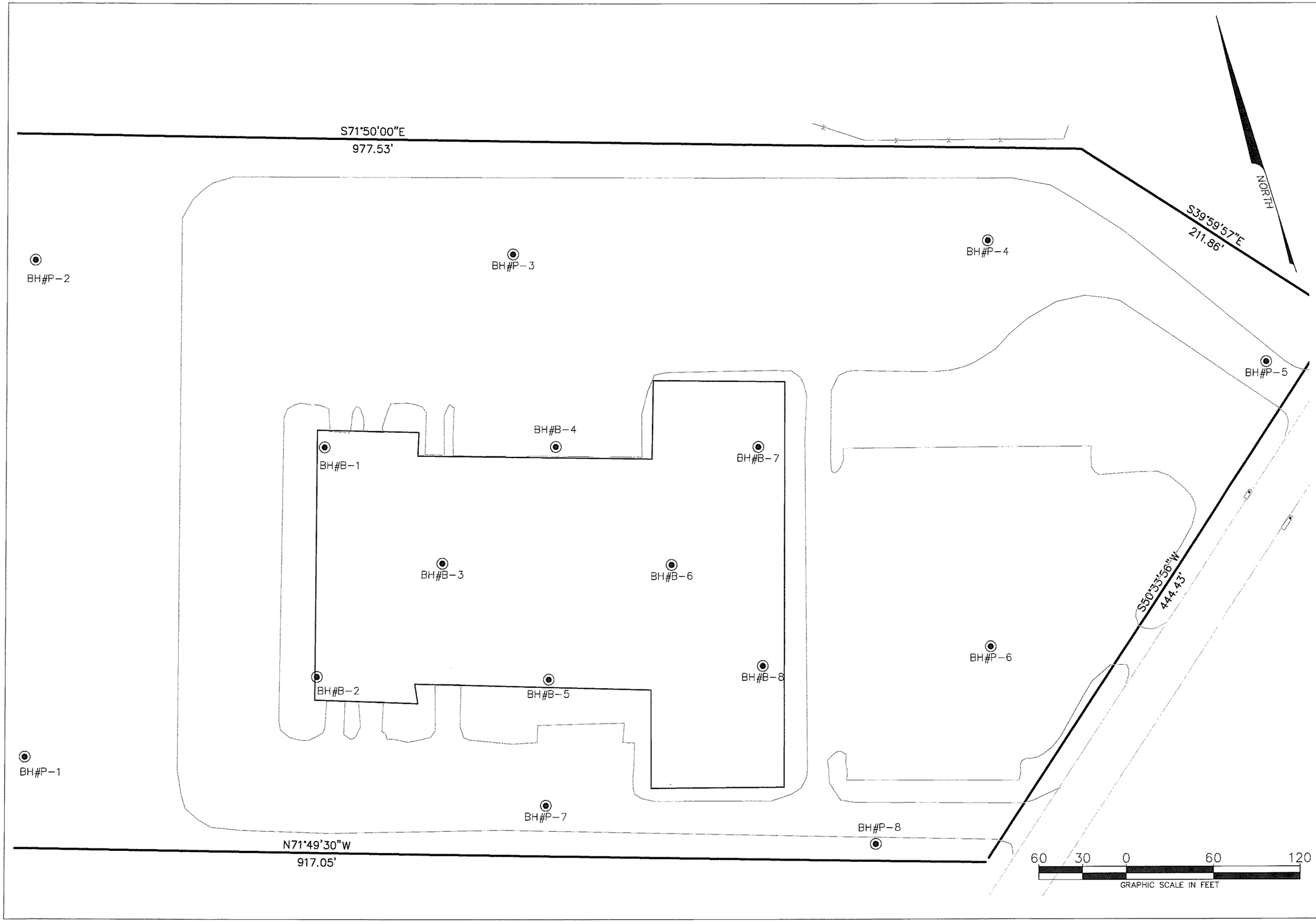
Location: 037° 22' 49.33" N 079° 09' 24.53" W

Copyright (C) 2008, MyTopo

Datum: NAD27

Appendix B

Test Boring Location Map



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HURT & PROFFITT
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BOREHOLE LOCATION PLAN
FOR
GLTC OPERATIONS AND MAINTENANCE BUILDING
LYNCHBURG, VIRGINIA

PROJECT NO.	20130553
G.L. NO.	264-02-C1.C
FILE NO.	
DATE:	10-14-2013
DRAWN BY:	TWB
CHECKED BY:	TDW

SHEET NO.
1 OF 1

Appendix C

Test Boring Logs

LOG OF BORING B-1

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 833.9
BORING DEPTH (ft): 30.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

FIELD DATA					LAB DATA				
						ATTERBERG LIMITS			
ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT / PERCENT RECOVERY / R.Q.D. / N-value	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)
		1	X	8 7 13					
		2							
		3	X	5 13 20					
830		4							
		5	X	2 6 11					
		6							
		7	X	2 3 7 10					
		8							
825		9							
		10	X	2 3 4 7					
		11							
		12							
		13							
820		14							
		15	X	2 4 6 10					
		16							
		17							
		18							
815		19							
		20	X	3 8 12 20					
		21							
		22							
		23							
810		24							
		25	X	6 8 12 20					
		26							
		27							
		28							
805		29							
		30	X	7 10 13 23					

DESCRIPTION OF STRATUM

RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist

with Sand

Medium

Stiff, fine Sandy

Very stiff, Reddish Brown Sandy SILT (ML), micaceous, moist

Medium, Grayish Olive Brown fine Silty SAND (SM), micaceous, moist

Boring Terminated at 30.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 26 feet

LOG OF BORING B-2

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 834.1
BORING DEPTH (ft): 30.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	6 11		17						RESIDUUM: Very stiff, Reddish Brown ELASTIC SILT (MH), contains quartz rock fragments, moist
		2	X	5 13		20						
830		4	X	9 17 26		43						Hard, Yellowish Brown Sandy SILT (ML), contains manganese staining, moist
		5	X	18 19 34		73						contains relict structure
		6										
		7										
825		9	X	9 26 50/5"		50/5"						Partially Weathered Rock: Olive, Grayish Brown Silty SAND (SM), moist
		10										
		11										
		12										
		13										
820		14	X	2 3 7		10						Stiff, Reddish Brown fine Sandy ELASTIC SILT (MH), contains mica, moist
		15										
		16										
		17										
		18										
815		19	X	3 3 6		9						Stiff, Olive, Yellowish Brown fine Sandy SILT (ML), micaceous, contains manganese staining, moist
		20										
		21										
		22										
		23										
810		24	X	2 3 6		9						
		25										
		26										
		27										
		28										
805		29	X	1 2 10		12						
		30										Boring Terminated at 30.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 26 feet

LOG OF BORING B-3

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia
PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 838.1
BORING DEPTH (ft): 30.50
PROPOSED SUBGRADE ELEVATION:
GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	8 7		12						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2										
835		3	X	5 8 8		14						
		4										
		5	X	2 6 11		17						
		6										
		7	X	2 3 3		8						
830		8										
		9										
		10	X	2 6 14		20						Very stiff, Orangish Brown Sandy SILT (ML), contains manganese staining, moist
		11										
		12										
825		13										
		14										
		15	X	2 3 6		9						Stiff
		16										
		17										
820		18										
		19										
		20	X	3 4 13		17						Very stiff
		21										
		22										
815		23										
		24										
		25	X	2 3 7		10						Stiff, Yellowish Olive Brown
		26										
		27										
810		28										
		29										
		30	X	8 16 18		32						Hard
												Boring Terminated at 30.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 26.6 feet

LOG OF BORING B-4

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/26/2013.

SURFACE ELEVATION: 837.4
BORING DEPTH (ft): 30.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	3 5 8		16						RESIDUUM: Very stiff, Reddish Brown ELASTIC SILT (MH), moist
835		2										
		3	X	8 9 12		20						
		4										
		5	X	6 6 9		15						
		6										
830		7	X	2 3 3		9						Stiff, Orangish Brown
		8										
		9										
		10	X	2 3 4		7						Medium, Reddish Brown, contains relict structure
		11										
825		12										
		13										
		14	X	2 3 4		7						
		15										
		16										
820		17										
		18										
		19	X	2 3 3		6						Dark Reddish Brown, contains manganese staining
		20										
		21										
815		22										
		23										
		24	X	17 24 19		43						Dense, Reddish Brown Silty SAND (SM) contains quartz rock fragments, dry
		25										
		26										
810		27										
		28										
		29	X	6 8 17		23						Very stiff, Orangish Brown Sandy SILT (ML) contains manganese staining, moist
		30										

Boring Terminated at 30.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 27 feet

LOG OF BORING B-5

Hurt & Proffitt, Inc.
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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 843.3
BORING DEPTH (ft): 30.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft): 26.70
GROUNDWATER DEPTH AFTER 24 HRS (ft): 23.90

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D. N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	5 8 8	16						RESIDUUM: Very stiff, Orangish Brown ELASTIC SILT (MH), moist
		2									
840		3	X	5 9 15	24						
		4									
		5	X	5 10 10	20						
		6									
		7	X	3 4 5	9						Stiff
835		8									
		9									
		10	X	2 3 3	6						Medium, contains manganese staining, decreasing plasticity
		11									
		12									
830		13									
		14									
		15	X	3 8 8	11						Stiff
		16									
		17									
825		18									
		19									
		20	X	5 9 9	14						
		21									
		22									
820		23				▼					
		24									
		25	X	3 8 8	13						
		26				▽					
		27									
815		28									
		29									
		30	X	24 50/4"	50/4"						Partially Weathered Rock: Olive Greenish Gray Silty SAND (SM), moist
											Boring Terminated at 30.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 26.8 feet

LOG OF BORING B-6

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 842.2
BORING DEPTH (ft): 30.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	8 8		13						RESIDUUM: Stiff, Reddish Orangish Brown ELASTIC SILT (MH), moist
840		2										
		3	X	10 13		23						Very stiff, contains quartz rock fragments
		4										
		5	X	4 9		16						
		6										
835		7	X	3 8		11						Stiff
		8										
		9										
		10	X	3 9		16						Very stiff, Orangish Brown contains manganese staining
		11										
830		12										
		13										
		14										
		15	X	7 8 11		19						Sandy, contains quartz rock fragments
		16										
825		17										
		18										
		19										
		20	X	4 13		20						
		21										
820		22										
		23										
		24										
		25	X	5 45		60						Hard, Olive Yellowish Brown Sandy SILT (ML), contains weathered rock fragments, moist
		26										
815		27										
		28										
		29										
		30	X	6 10 15		25						Very stiff

Boring Terminated at 30.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 26.4 feet

LOG OF BORING B-7

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia
PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 835.8
BORING DEPTH (ft): 61.50
PROPOSED SUBGRADE ELEVATION:
GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft): 38.40

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
835		1	X	8 7		12						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2 3	X	5 9 13		22						Very stiff
		4 5	X	3 5 6		11						Stiff, Reddish Orangish Brown
830		6 7 8	X	3 4 8		12						
		9 10	X	3 6		9						Sandy
825		11 12 13 14										
		15	X	5 8 11		19						Very stiff
820		16 17 18										
		19 20	X	2 5 8		13						Stiff, Olive Yellowish Brown Sandy SILT (ML), contains manganese staining, moist
815		21 22 23 24										
		25	X	3 3 13		16						
810		26 27 28 29										
		30	X	5 8 11		19						Very stiff, Reddish Brown, micaceous
805		31 32 33 34										
		35	X	4 8 15		23						
800		36 37 38					▼					
		39 40	X	6 9 10		17						
795		41 42 43 44										
		45	X	26 35 40		70						Hard, Brown fine to medium Sandy SILT(ML), moist
790		46 47 48 49										
		50	X	12 50/1"		50/1"						Partially Weathered Rock: Brown Sandy SILT (ML), wet
785		51 52			83							Diamond Bit Coring Initiated at 51.5 feet, upon Auger Refusal
		53 54			0							
		55			42							
780		56 57			13							
		58 59 60			100							Actinolite Schist (metabasalt)- Highly fractured, Moderately weathered, Olive Greenish
775		61			56							Actinolite Schist (metabasalt)- Highly fractured, Moderately weathered, Greenish Gray, contains quartzite/marble healed fractures
												Actinolite Schist (metabasalt)- Moderately fractured, Slightly weathered (below

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.

LOG OF BORING B-7

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, VA 24501
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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION:
BORING DEPTH (ft): 61.50
PROPOSED SUBGRADE ELEVATION:
GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft): 38.40

FIELD DATA						LAB DATA				
						ATTERBERG LIMITS				
ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D. N-value	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)

DESCRIPTION OF STRATUM

59 feet), Greenish Gray, contains quartz/calcite, contains manganese @ 58 feet.

Diamond Bit Coring Terminated at 61.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.

LOG OF BORING B-8

Hurt & Proffitt, Inc.
2524 Langhorne Road
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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/20/2013.

SURFACE ELEVATION: 847.2
BORING DEPTH (ft): 39.40
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft): 21.60

ELEVATION (feet)	DEPTH (feet)	SAMPLES / BLOW COUNT	PERCENT RECOVERY / R.Q.D. / N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
845	1	62 26	39	28	54	35	19	63	RESIDUUM: Hard, Reddish Brown ELASTIC SILT (MH), moist
	2	9							
	3	19 22	41						
	4	6							
	5	20 23	43						
	6	3							
840	7	13 32	45						
	8			15	31	21	10	66	
	9	5							Partially Weathered Rock: Hard, Grayish Brown fine to coarse Clayey SILT, contains quartz rock fragments, moist
	10	18 50/3"	50/3"						
	11								
835	12								
	13								
	14	9							
	15	18 50/3"	50/3"						
	16								
830	17								
	18								
	19	3							
	20	5 12	20						Very stiff, Orangish Brown Sandy SILT (ML), moist
	21								
825	22								
	23								
	24	5							Partially Weathered Rock: Olive Grayish Brown Silty SAND (SM), dry
	25	28 50/1"	50/1"						
	26								
820	27								
	28		100						Diamond Bit Coring Initiated at 27.5 feet.
	29								
	30		0						
	31								
815	32		64						
	33		62						
	34								
	35								Actinolite Schist (metabasalt)- Slightly weathered, Highly fractured, Greenish Gray, fracturing at 60-70 degrees to the core axis
	36								
810	37		100						Actinolite Schist (metabasalt)- Slightly weathered, Moderately fractured, Greenish Gray, fracturing at 60-70 degrees to the core axis
	38		83						
	39								Actinolite Schist (metabasalt)- Slightly weathered, Slightly fractured, Greenish Gray, fracturing at 45-55 degrees to the core axis
									Diamond Bit Coring terminated at 39.4 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.

LOG OF BORING P-1

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http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 820.6
BORING DEPTH (ft): 20.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
820		1		8 6		11						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2		5 8		14						
		3		5 9								
		4		5 8		15						Sandy, contains mica
815		5		5 8		16						Very stiff, contains quartz rock fragments
		6		2 3		7						Medium, contains relict structure and manganese staining
		7		2 5								
		8										
		9										
810		10										
		11										
		12										
		13										
		14		3 3		10						Stiff, Reddish Brown Sandy SILT (ML), micaceous, moist
805		15		4 6								
		16										
		17										
		18										
		19		3 8		12						Medium, Olive Gray fine Silty SAND (SM), contains vertical relict structure, moist
		20										

Boring Terminated at 20.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 16.9 feet

LOG OF BORING P-2

Hurt & Proffitt, Inc.
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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/26/2013.

SURFACE ELEVATION: 822.4
BORING DEPTH (ft): 20.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	6 7		12						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
820		2 3	X	8 11		19						Very stiff
		4 5	X	3 6 8		14						Stiff
815		6 7 8	X	3 3 5		8						
		9 10	X	5 6 6		11						Stiff, Orangish Brown Sandy SILT (ML), moist
810		11 12 13										
		14 15	X	4 9 13		22						Very stiff
805		16 17 18										
		19 20	X	2 2 3		5						Medium

Boring Terminated at 20.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 17.2 feet

LOG OF BORING P-3

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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/26/2013.

SURFACE ELEVATION: 831.7
BORING DEPTH (ft): 20.50
PROPOSED SUBGRADE ELEVATION:
GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
830		1	X	8		12						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2		7								
		3	X	8		19						Very stiff
		4		11								
		5	X	3		16						
		6		4								
825		7	X	9		9						Stiff, Orangish Brown with Sand
		8		2								
		9		3								
		10	X	3		6						Medium
820		11		3								
		12										
		13										
		14										
		15	X	3		8						Medium, Orangish Brown Sandy SILT (ML), contains manganese staining
		16		4								
815		17										
		18										
		19		3								
		20	X	5		10						Medium, Reddish Brown fine Silty SAND (SM), contains manganese staining, micaceous, moist

Boring Terminated at 20.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 17.4 feet

LOG OF BORING P-4

Hurt & Proffitt, Inc.
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http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/26/2013.

SURFACE ELEVATION: 819.4
BORING DEPTH (ft): 20.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1	X	2 3 5		8						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2	X	5 5 6		11						
815		4	X	8 11		19						
		6	X	3 3 6		13						
		8										
810		9										
		10	X	4 5 8		13						Stiff, Orangish Brown Sandy SILT (ML), moist
		11										
		12										
		13										
805		14	X	3 3 5		8						Olive Yellow
		16										
		17										
		18										
800		19	X	3 9 13		22						Very stiff
		20										Boring Terminated at 20.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 16.8 feet

LOG OF BORING P-5

Hurt & Proffitt, Inc.
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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/26/2013.

SURFACE ELEVATION: 806.9
BORING DEPTH (ft): 12.00
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												4 inches of Rootmat and Topsoil
805		1		2 6		9						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2		4 8		20						
		3		12								
		4		4 8		19						Very stiff, contains quartz rock fragments
		5		11								
		6		50/4"		50/4"						
800		7										Partially Weathered Rock: Grayish Greenish Brown Silty SAND (SM), dry
		8										
		9		50/5"		50/5"						Greenish Gray
		10										
		11										
795		12										Auger Refusal at 12.0 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 10 feet

LOG OF BORING P-6

Hurt & Proffitt, Inc.
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Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/20/2013.

SURFACE ELEVATION: 835.6
BORING DEPTH (ft): 14.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
835		1	X	3 9		14						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), dry
		2										
		3	X	6 13		22						Very stiff, moist
		4										
		5	X	9 15		24						
830		6										
		7	X	16 22		38						Dense, Orangish Silty SAND (SM), contains manganese staining, moist
		8										
		9										
		10	X	5 11 26		37						
825		11										
		12										
		13										Partially Weathered Rock: Greenish Gray Silty SAND (SM), dry
		14										
												Auger Refusal at 14.5 feet.

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 11 feet

LOG OF BORING P-7

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http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/20/2013.

SURFACE ELEVATION: 847.4
BORING DEPTH (ft): 20.50
PROPOSED SUBGRADE ELEVATION:
GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D.	N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		1		4 15		24						6 inches of Rootmat and Topsoil
845		2		7 13		38						RESIDUUM: Very stiff, Reddish Brown ELASTIC SILT (MH), dry
		3		23								
		4		3								Hard, moist
		5		11		18						
		6		2								
840		7		8 16		24						Very stiff
		8										
		9		11								Very stiff, Yellowish Olive Brown Sandy SILT (ML), contains manganese staining moist
		10		18 26		44						
		11										
835		12										Hard
		13										
		14		5								
		15		50/5"		50/5"						Partially Weathered Rock: Greenish Gray Silty SAND (SM), dry
		16										
830		17										
		18										
		19		50/5"		50/5"						
		20										Boring Terminated at 20.0 feet

N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 17 feet

LOG OF BORING P-8

Hurt & Proffitt, Inc.
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Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

DRILLING DETAILS:
Drilled by N. Hurdis using CME-45C and Continuous Flight Hollow Stem Augers. Boring completed 9/25/2013.

SURFACE ELEVATION: 850.8
BORING DEPTH (ft): 13.50
PROPOSED SUBGRADE ELEVATION:

GROUNDWATER DEPTH AT COMPLETION (ft):
GROUNDWATER DEPTH AFTER 24 HRS (ft):

ELEVATION (feet)	SOIL SYMBOL	DEPTH (feet)	SAMPLES	BLOW COUNT	PERCENT RECOVERY / R.Q.D. N-value	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
850		1	X	4 7	14						RESIDUUM: Stiff, Reddish Brown ELASTIC SILT (MH), moist
		2									
		3	X	5 6 9	17						Very stiff
		4									
		5	X	31 33	44						Hard
845		6									
		7	X	18 25	40						Dense, Orangish Brown Silty SAND (SM), moist
		8									
		9									
		10	X	14 38	52						contains manganese staining
840		11									
		12									
		13		50/4" 50/4"							Partially Weathered Rock: Greenish Gray Silty SAND (SM), dry
											Auger Refusal at 13.5 feet.

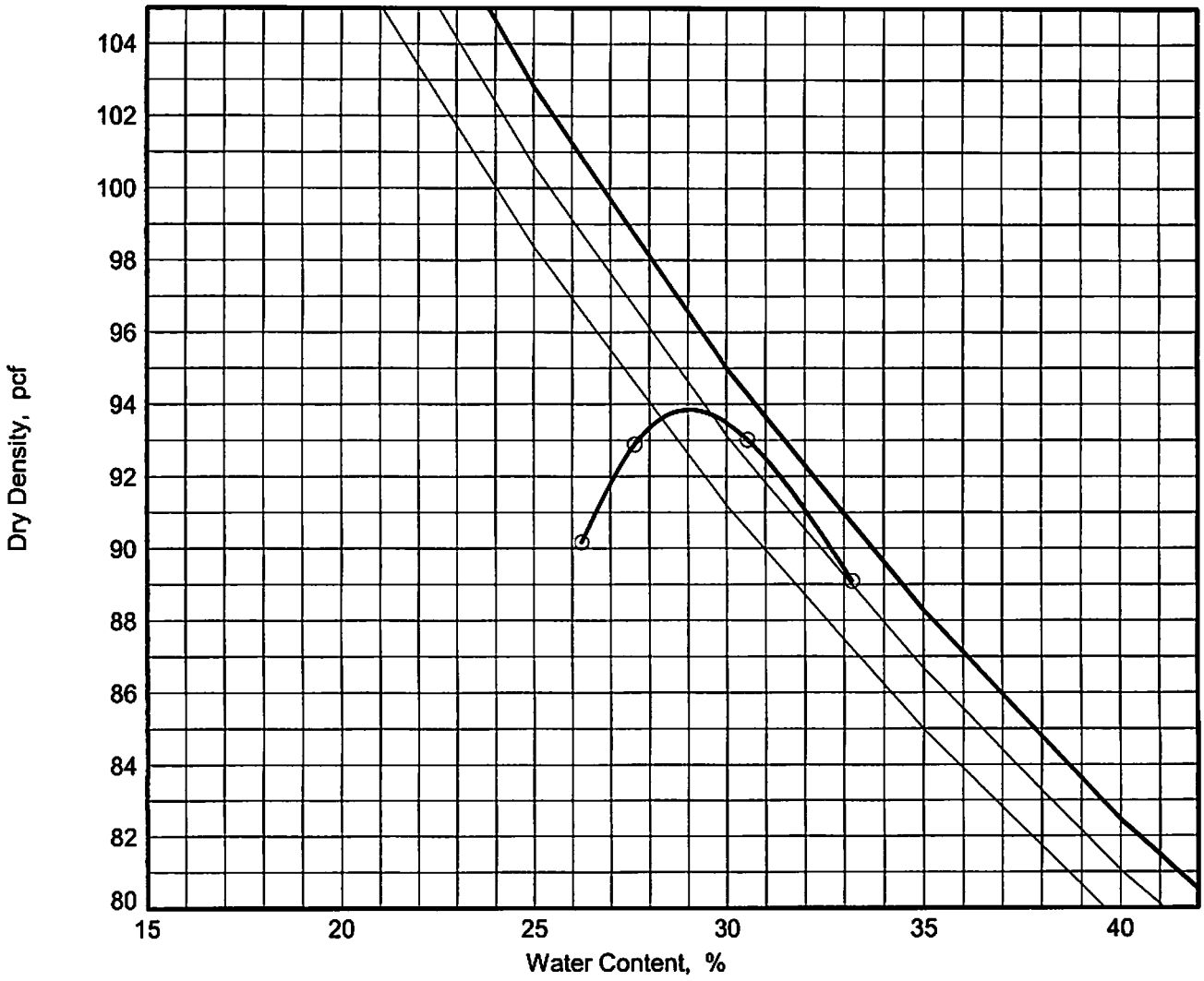
N - Standard Penetration Test Resistance (ASTM D 1586)
R.Q.D. - Rock Quality Designation

NOTES:
Topsoil stripped to gain drill rig access. Typical topsoil depth onsite was 6-8 inches.
Cave-in at 12.6 feet

Appendix D

Standard Proctor Curve

MOISTURE - DENSITY RELATIONSHIP



80

Standard Proctor - ASTM D 698, Method A, using the Dry Preparation method and Manual Rammer

MATERIAL DESCRIPTION	AASHTO	SAMPLE ID: **B-8**
Red SANDY ELASTIC SILT (MH)	A-7-5(11)	Maximum Dry Density = **94.0 pcf** Optimum Moisture = **29.0 %**

Natural Moisture	Specific Gravity	Liquid Limit	Plasticity Index	% < 3/4 in.	% < 3/8 in.	% < No. 4	% < No. 200
27.8		54	19	99.1	97.8	94.8	62.8

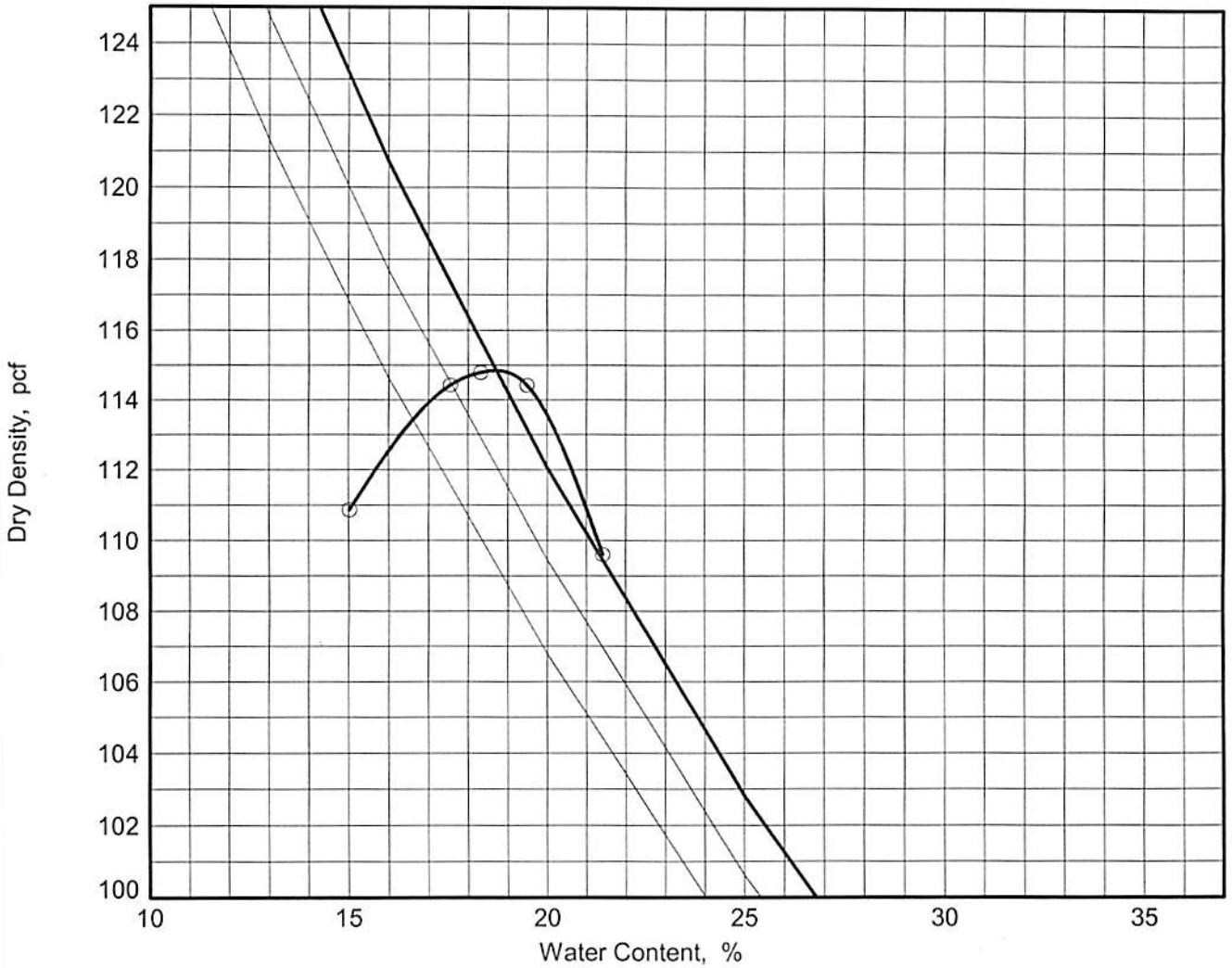
Sampled by S. Osbeck September 20, 2013
Sample location: B-8 (1'-9') & P-7 (0'-8") combined
Proposed use:

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, Virginia 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

MOISTURE - DENSITY RELATIONSHIP



100

Standard Proctor - ASTM D 698, Method A, using the Dry Preparation method and Manual Rammer

MATERIAL DESCRIPTION	AASHTO	SAMPLE ID: **B-8**
Olive Brown SANDY LEAN CLAY (CL)	A-4(6)	Maximum Dry Density = **115.0 pcf** Optimum Moisture = **18.4 %**

Natural Moisture	Specific Gravity	Liquid Limit	Plasticity Index	% < 3/4 in.	% < 3/8 in.	% < No. 4	% < No. 200
15.3		31	10	100.0	99.2	96.2	66.2

Sampled by S. Osbeck September 20, 2013

Sample location: B-8 (9'-12')

Proposed use:

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, Virginia 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
http://www.HandP.com

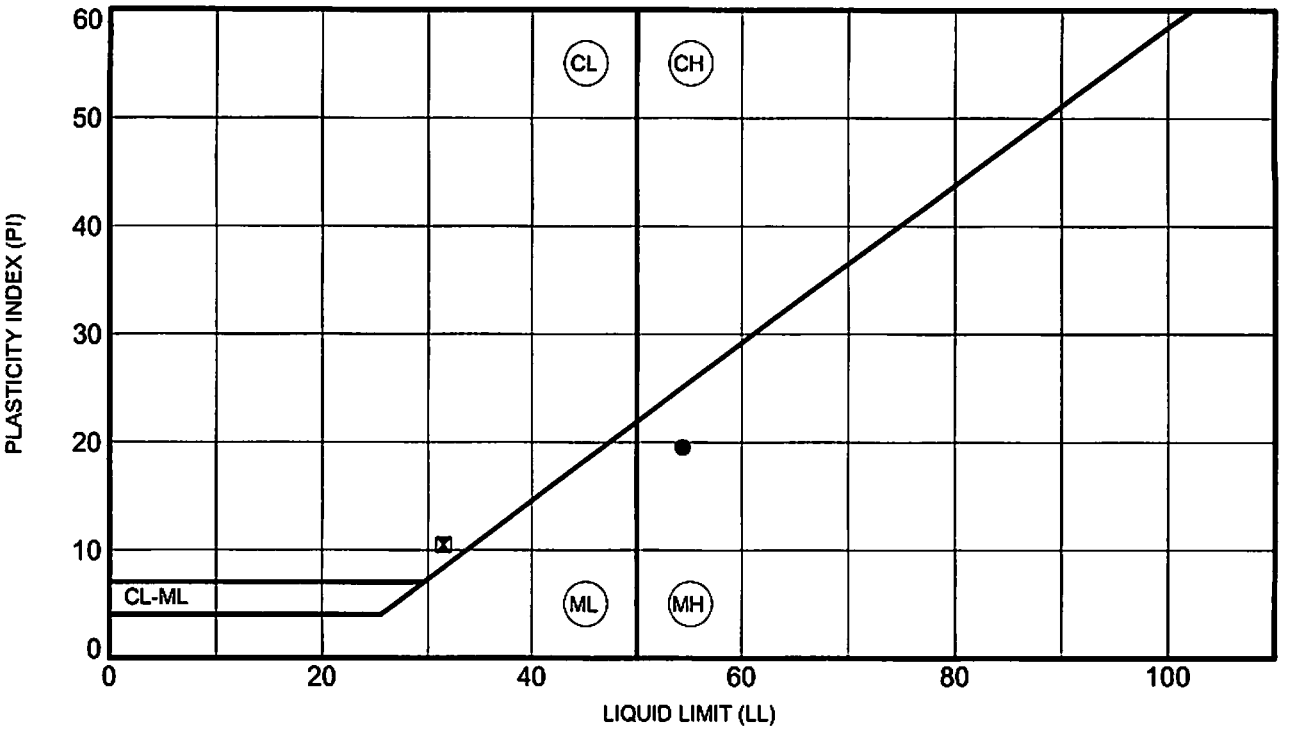
CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

Appendix E

Atterberg Limit Result

ATTERBERG LIMITS' RESULTS



	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-8	1.0	54	35	19	62.8	Red SANDY ELASTIC SILT (MH)
⊠	B-8	9.0	31	21	10	66.2	Olive Brown SANDY LEAN CLAY (CL)

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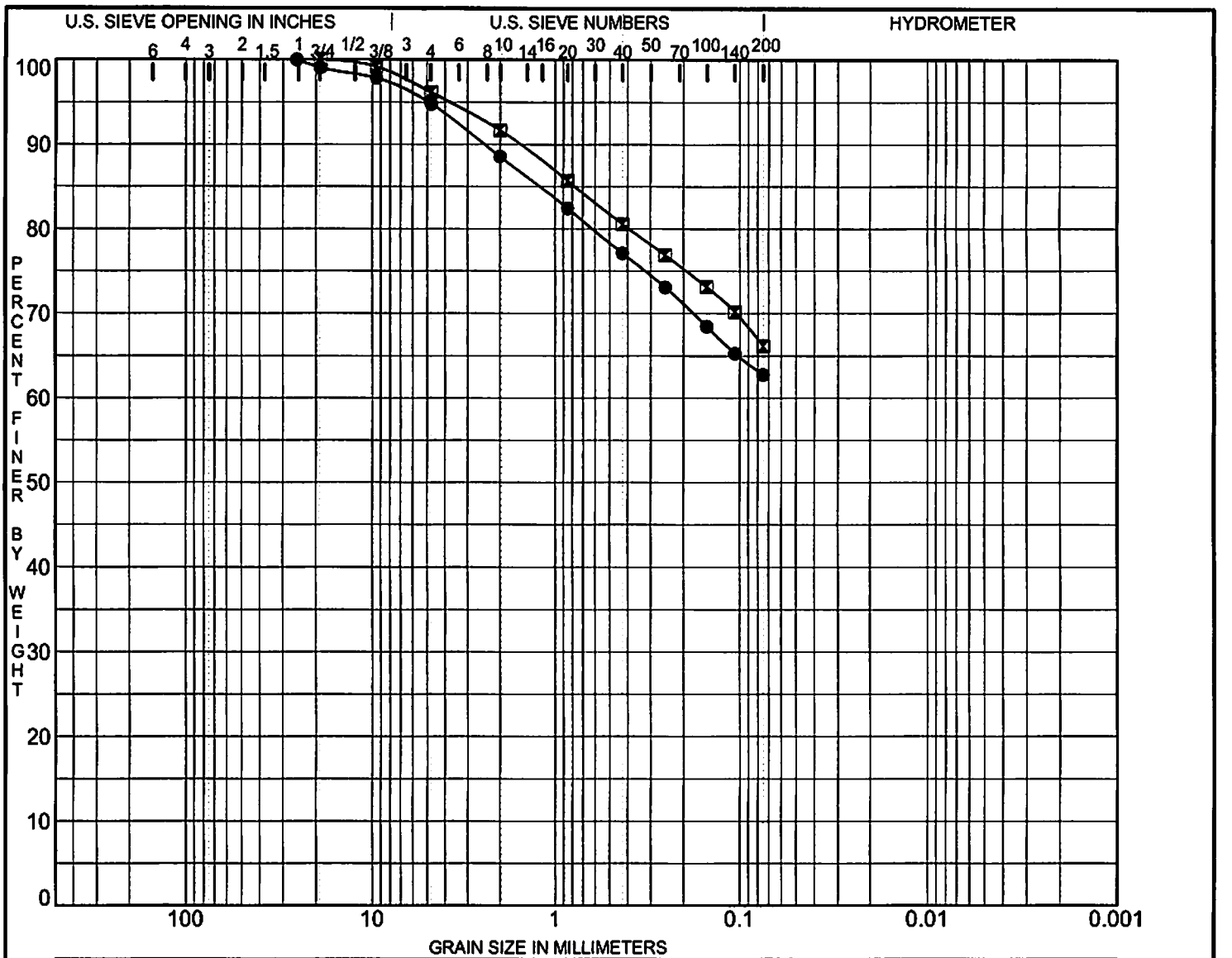
http://www.HandP.com

CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

Appendix F

Sieve Analysis Result



	Specimen Identification		Classification	MC%	LL	PL	PI
●	B-8	1.0	Red SANDY ELASTIC SILT (MH)	27.8	54	35	19
⊠	B-8	9.0	Olive Brown SANDY LEAN CLAY (CL)	15.3	31	21	10

	Specimen Identification		D100	D60	D30	D10	Cc	Cu	%Gravel	%Sand	%Silt	%Clay
●	B-8	1.0	25.40						5.2	32.0	62.8	
⊠	B-8	9.0	19.00						3.8	30.0	66.2	

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, Virginia 24501
Telephone: (434) 847-7796
Fax: (434) 847-0047
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CLIENT: Wendel
PROJECT: GLTC Operations & Maintenance Facility
LOCATION: Lynchburg, Virginia

PROJECT NO. 20130553

Appendix G

CBR Analysis Result

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, Virginia 24501
(phone) 434-847-7796 (fax) 434-847-0047

Project:	GLTC Operations & Maintenance Facility
Project. No:	20130553
Location:	Lynchburg, VA (B-8, 1'-9' & P-7, 0'-8')
Date	October 1, 2013
	Sample # 1

California Bearing Ratio Computations (VTM-8 Modified)

Soil Description: Red Sandy Elastic Silt (MH)
Liquid Limit: 54
Plasticity Index: 19

Minus 200 (%): 62.8
Proctor Density (pcf): 94.0
Optimum Moisture (%): 29.0

Computed Weight of Compacted Soil in CBR Mold

0.075	x	94.0	=	7.05	lbs., weight of dry soil
453.6	x	7.05	=	3198	grams, weight of dry soil
3198	x	1.290	=	4125	grams, weight of wet soil

Actual Weight and Density of Soil in CBR Mold

	Soaked Mold (s)	Soaked Mold After Immersion (i)	
Wt. of mold and wet soil	11291	11334	grams
Wt. of mold	7117	7117	grams
Wt. of wet soil (S_w)	4174	4217	grams
Moisture content (w)	29.5	30.7	percent
Wt. of dry soil	3224	3226	grams
Percent Density Obtained:	100.8 %	100.8 %	

Compaction Effort
3 Layers
56 Blows/Layer

Mold ID: # 26

Density (D) = S_w / (V x (1+w) x 453.6), w is expressed as a decimal

D_s = 94.8 V_s = 0.0750 w = 0.295
D_i = 94.8 V_i = 0.0751 w = 0.307

V_i = resulting volume after soak, $V_i = [(1/4\pi d^2) \times (ho + \Delta h)] \times 0.0005787$

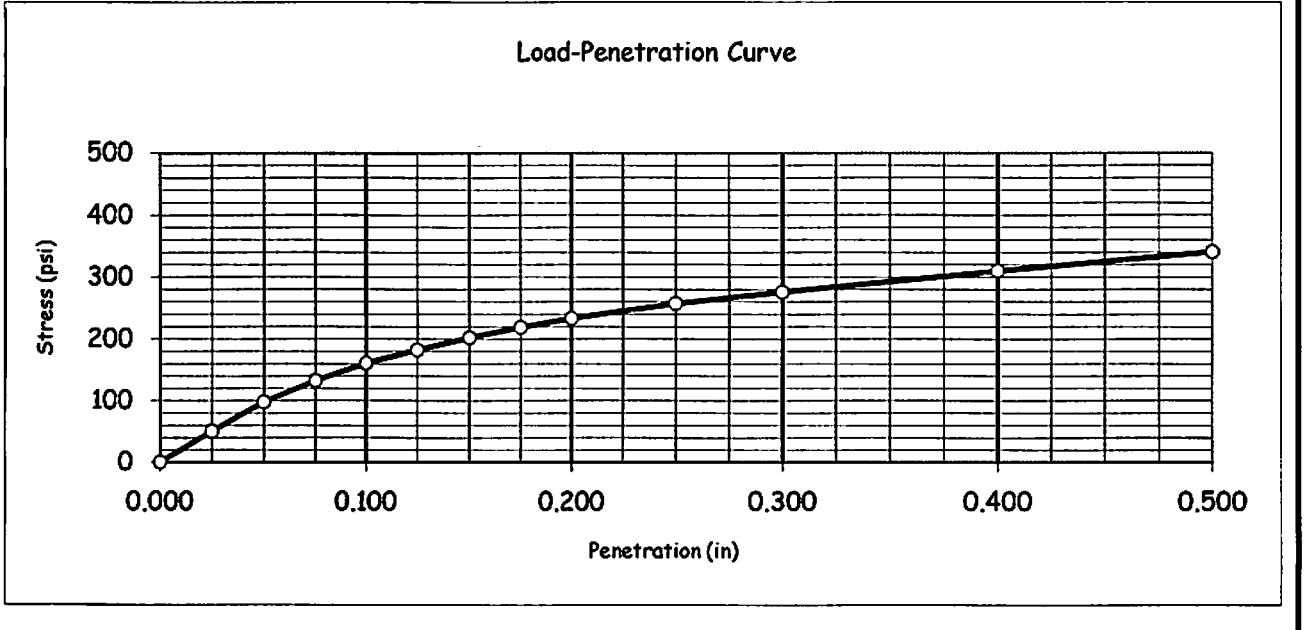
Computation of Swell

Reading before immersion	0.034	points
Reading after immersion	0.037	points
Amount of Swell	0.003	points

% Swell = 0.07

Determination of CBR Value (Penetration and Total Load)

Inches	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.250	0.300	0.400	0.500
Stress on Piston (psi)	0	50	98	133	161	182	202	219	234	257	276	310	341
Total load after 4 day soak	0	151	294	398	483	547	607	657	701	772	828	929	1022



CBR Value (0.1") = 16.1 %

Hurt & Proffitt, Inc.
2524 Langhorne Road
Lynchburg, Virginia 24501
(phone) 434-847-7796 (fax) 434-847-0047

Project:	GLTC Operations & Maintenance Facility
Project. No:	20130553
Location:	Lynchburg, VA (B-8, 9'-12')
Date	October 1, 2013
	Sample # 2

California Bearing Ratio Computations (VTM-8 Modified)

Soil Description: Olive Brown Sandy Lean Clay (CL)
Liquid Limit: 31
Plasticity Index: 10

Minus 200 (%): 66.2
Proctor Density (pcf): 115.0
Optimum Moisture (%): 18.4

Computed Weight of Compacted Soil in CBR Mold

0.075	x	115.0	=	8.63	lbs., weight of dry soil
453.6	x	8.63	=	3912	grams, weight of dry soil
3912	x	1.184	=	4632	grams, weight of wet soil

Actual Weight and Density of Soil in CBR Mold

	Soaked Mold (s)	Soaked Mold After Immersion (i)	
Wt. of mold and wet soil	11686	11729	grams
Wt. of mold	6978	6978	grams
Wt. of wet soil (S_w)	4708	4751	grams
Moisture content (w)	19.1	22.1	percent
Wt. of dry soil	3952	3891	grams
Percent Density Obtained:	101.0 %	98.9 %	

Compaction Effort
3 Layers
56 Blows/Layer

Mold ID: #63

Density (D) = S_w / (V x (1+w) x 453.6), w is expressed as a decimal

D_S = 116.2 V_s = 0.0750 w = 0.191
D_I = 113.7 V_I = 0.0754 w = 0.221

V_i = resulting volume after soak, $V_i = [(1/4\pi d^2) \times (ho + \Delta h)] \times 0.0005787$

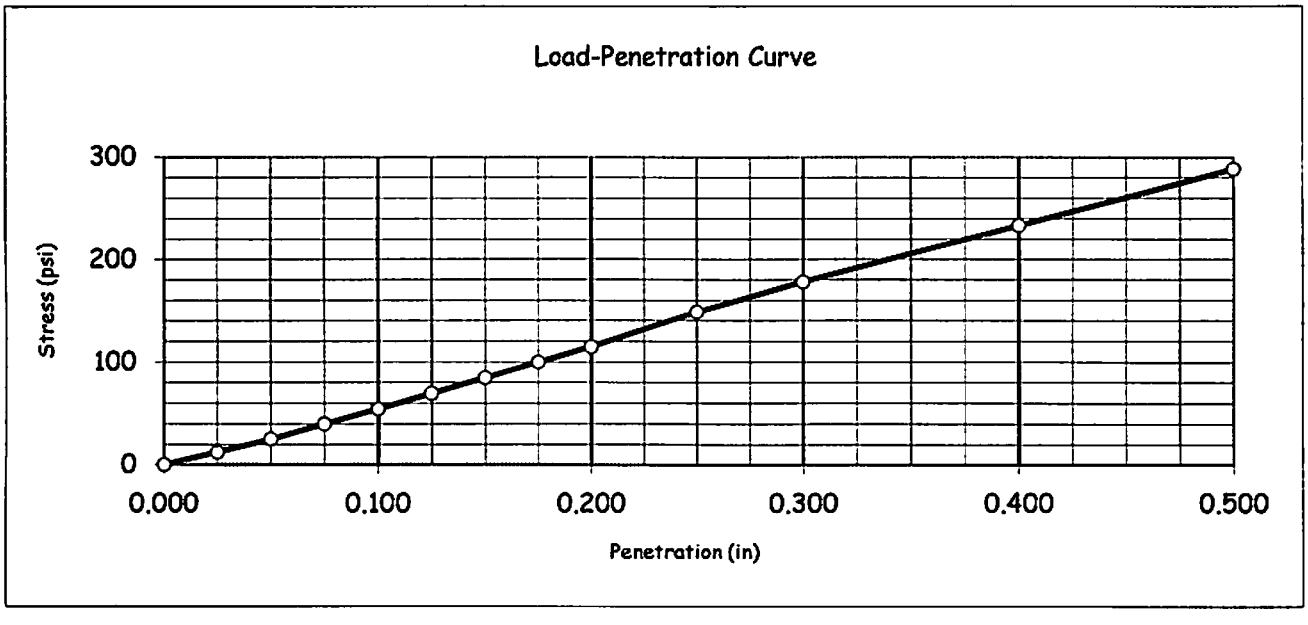
Computation of Swell

Reading before immersion	0.057	points
Reading after immersion	0.082	points
Amount of Swell	0.025	points

% Swell = 0.55

Determination of CBR Value (Penetration and Total Load)

Inches	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.250	0.300	0.400	0.500
Stress on Piston (psi)	0	12	25	40	55	70	84	100	115	149	178	233	288
Total load after 4 day soak	0	37	76	120	164	209	253	300	345	446	534	700	865



CBR Value (0.1") = 5.5 %